DEPARTMENT OF COMMERCE
BUREAU OF FISHERIES

REPORT

OF THE

UNITED STATES COMMISSIONER OF FISHERIES

FOR THE FISCAL YEAR 1926

WITH

APPENDIXES

HENRY O'MALLEY
Commissioner

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DEPARTMENT OF COMMERCE

BUREAU OF FISHERIES

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REPORT OF THE COMMISSIONER OF FISHERIES [1]

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DEPARTMENT OF COMMERCE,
BUREAU OF FISHERIES,
Washington, July 1, 1926.

SIR: I have the honor to submit the following report of the major operations of the Bureau of Fisheries during the fiscal year ended June 30, 1926.

The past year has been noteworthy for the progress made in all phases of the fisheries and for the effectiveness of the bureau's work. As a result, greater appreciation of the bureau's helpfulness and demands for a much larger measure of service have been noted. Unusual interest has been shown in the development of the science of aquiculture; in the conduct of fisheries investigations as the basis for proper legislation and control; in expanding the present scale of fish propagation for stocking waters; in making provision for annual inventories of the fisheries to reveal their trend and the need for further protection or expansion; in the conduct of technological investigations to effect additional improvements in the use and merchandising of fishery products; in insuring the perpetuity of the Alaska salmon fisheries; and in solving fisheries problems international in character. Our commercial fisheries are in a more prosperous condition, and the progressive leaders are taking advantage of this state of affairs to make greater progress in stabilizing the industry and in making the products of our fisheries available to a greater number of people. Credit is due the bureau's personnel in meeting the exacting and growing demands for service. Without thorough application and a considerable measure of overtime work much of this could not have been accomplished.

INTERNATIONAL FISHERIES CONVENTIONS

NORTHERN PACIFIC HALIBUT CONVENTION

Under the terms of a "Convention between the United States and Great Britain for the Preservation of the Halibut Fishery of the Northern Pacific Ocean, Including Bering Sea," exchange of ratifications being concurred in at Washington on October 21, 1924, the following articles were agreed upon:

ARTICLE I

The nationals and inhabitants and the fishing vessels and boats of the United States and of the Dominion of Canada, respectively, are hereby prohibited from fishing for halibut (Hippoglossus) both in the territorial waters and in the high seas off the western coasts of the United States, including Bering Sea, and of the Dominion of Canada, from the 16th day of November next after the date of the exchange of ratifications of this convention to the 15th day of the following February, both days inclusive, and within the same period yearly thereafter, provided that upon the recommendation of the International Fisheries Commission hereinafter described this close season may be modified or suspended at any time after the expiration of three such seasons by a special agreement concluded and duly ratified by the high contracting parties.

It is understood that nothing contained in this article shall prohibit the nationals or inhabitants and the fishing vessels or boats of the United States and of the Dominion of Canada from fishing in the waters hereinbefore specified for other species of fish during the season when fishing for halibut in such waters is prohibited by this article. Any halibut that may be taken incidentally when fishing for other fish during the season when fishing for halibut is prohibited under the provisions of this article may be retained and used for food for the crew of the vessel by which they are taken. Any portion thereof not so used shall be landed and immediately turned over to the duly authorized officers of the Department of Commerce of the United States or of the Department of Marine and Fisheries of the Dominion of Canada. Any fish turned over to such officers in pursuance of the provisions of this article shall be sold by them to the highest bidder, and the proceeds of such sale, exclusive of the necessary expenses in connection therewith, shall be paid by them into the treasuries of their respective countries.

ARTICLE II

Every national or inhabitant, vessel or boat of the United States or of the Dominion of Canada engaged in halibut fishing in violation of the preceding article may be seized except within the jurisdiction of the other party by the duly authorized officers of either high contracting party and detained by the officers making such seizure and delivered as soon as practicable to an authorized official of the country to which such person, vessel, or boat belongs, at the nearest point to the place of seizure, or elsewhere, as may be mutually agreed upon. The authorities of the nation to which such person, vessel, or boat belongs alone shall have jurisdiction to conduct prosecutions for the violation of the provisions of the preceding article or of the laws or regulations which either high contracting party may make to carry those provisions into effect, and to impose penalties for such violations; and the witnesses and proofs necessary for such prosecutions, so far as such witnesses or proofs are under the control of the other high contracting party, shall be furnished with all reasonable promptitude to the authorities having jurisdiction to conduct the prosecutions.

ARTICLE III

The high contracting parties agree to appoint within two months after the exchange of ratifications of this convention a commission to be known as the International Fisheries Commission, consisting of four members, two to be appointed by each party. This commission shall continue to exist so long as this convention shall remain in force. Each party shall pay the salaries and expenses of its own members, and joint expenses incurred by the commission shall be paid by the two high contracting parties in equal moieties.

The commission shall make a thorough investigation into the life history of the Pacific halibut, and such investigation shall be undertaken as soon as practicable. The commission shall report the results of its investigation to the two Governments and shall make recommendations as to the regulation of the halibut fishery of the North Pacific Ocean, including the Bering Sea, which may seem to be desirable for its preservation and development.

ARTICLE IV

The high contracting parties agree to enact and enforce such legislation as may be necessary to make effective the provisions of this convention, with appropriate penalties for violations thereof.

ARTICLE V

This convention shall remain in force for a period of five years, and thereafter until two years from the date when either of the high contracting parties shall give notice to the other of its desire to terminate it. It shall be ratified in accordance with the constitutional methods of the high contracting parties. The ratification shall be exchanged in Washington as soon as practicable, and the convention shall come into force on the day of the exchange of ratifications.

The enabling act, approved June 7, 1924, putting into effect the terms of the treaty, follows:

AN ACT FOR THE PROTECTION OF THE NORTHERN PACIFIC HALIBUT FISHERY

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled

SECTION 1. *Short title.*—This act may be cited as the Northern Pacific halibut act.

SEC. 2. *Definition of terms.*—For the purposes of this act "close season" shall mean the period from the 16th day of November in any year to the 15th day of February in the next following year, both days inclusive, or any other close season hereafter fixed by agreement between the United States and Canada; "territorial waters of the United States" shall mean the waters contiguous to the western coast of the United States and the waters contiguous to the coast of Alaska; "territorial waters of Canada" shall mean the waters contiguous to the western coast of Canada, and "prohibited waters" shall mean the territorial waters of the United States, the territorial waters of Canada, and the high seas, including Bering Sea, extending westerly from the limits of the territorial waters of the United States and of Canada.

SEC. 3. *Fishing unlawful, when.*—It shall be unlawful for any person to fish for, or catch, or attempt to catch, any halibut (Hippoglossus) at any time during the close season in the territorial waters of the United States, or for any national or inhabitant of the United States to fish for, or catch, or attempt to catch, any halibut at any time during the close season in prohibited waters. The unintentional catching of halibut, when legally fishing for other species of fish, shall not constitute a violation of this act if such halibut shall be used for food by the crew of the vessel catching the same, or be landed and immediately delivered to any authorized official of the Bureau of Fisheries of the Department of Commerce of the United States or the fishing authorities of the Dominion of Canada. The halibut delivered to any official of the United States pursuant to the provisions of this section shall be sold by the Department of Commerce to the highest bidder for cash, and the proceeds therefrom, exclusive of necessary expenses in connection therewith, shall be covered into the Treasury of the United States.

SEC. 4. *Unlawful port use; departures.*—No person, firm, or corporation shall use any port of or place in the United States to furnish, prepare, or outfit any vessel, boat, or other craft intended to be used in violation of this act, nor shall any person permit, or cause to be permitted, any vessel, boat, or other craft intended to be used in violation of this act to depart from any port of or place in the United States.

SEC. 5. *Unlawful port entry; possession.*—It shall be unlawful for any vessel, boat, or other craft having on board any halibut caught contrary to the provisions of this act to enter any port or place in the United States, or for any vessel, boat, or other craft to enter any such port or place while upon or in the prosecution of any voyage during which the vessel, boat, or other craft fished or was used in fishing for halibut in prohibited waters in the close season. It shall be unlawful for any person knowingly to have in his possession any halibut unlawfully caught under the provisions of this act.

SEC. 6. *Penalty.*—Any person violating any of the provisions of this act shall be fined not less than $100 nor more than $1,000 or imprisoned not more than one year, or both.

SEC. 7. *Patrols; searches.*—The President shall cause a patrol of naval or other public vessels designated by him to be maintained in such places and waters as to him shall seem expedient for enforcing this act, and any officer of any vessel engaged in such service, and any other officers designated by the President, may search any vessel, boat, or other craft in the Territorial waters of the United States and any vessel, boat, or other craft of the United States on the high seas when suspected of having violated or being about to violate the provisions of this act.

SEC. 8. *Canadian vessels and nationals.*—Every national or inhabitant and every vessel of Canada found violating this act shall be delivered as soon as practicable to an authorized official of Canada at the nearest point to the place of seizure, or elsewhere as the officials of the United States seizing the same and the authorized officials of Canada may agree upon, and the witnesses and proof necessary to the prosecution of said persons and vessels of Canada shall be furnished with reasonable promptitude to the authorities of Canada having jurisdiction thereof.

SEC. 9. *Seizure and forfeiture.*—Every vessel, boat, or craft employed in any manner in violating this act shall be seized by any collector, surveyor, inspector, officer of a revenue cutter, or person specified in section 7 hereof, and except as provided in section 8 hereof, every such vessel, boat, or craft, including its tackle, apparel, furniture, cargo, and stores, shall be forfeited to the United States by proper proceedings in any court of the United States in Alaska, California, Oregon, or Washington.

SEC. 10. *Fisheries Commission exemption.*—None of the inhibitions contained in this act shall apply to the International Fisheries Commission when engaged in any scientific investigation.

SEC. 11. *Appropriation.*—There is hereby authorized to be appropriated, out of any money in the Treasury not otherwise appropriated, the sum of $15,000 for the fiscal year 1925 for the salaries and expenses of the International Fisheries Commission.

SEC. 12. *Duration of act.*—This act shall take effect immediately and continue in force until the termination of the convention concluded by the United States and Great Britain on March 2, 1923, for the protection of the halibut fishery of the northern Pacific Ocean.

The American representatives on this commission are Henry O'Malley, Commissioner of Fisheries, and Miller Freeman, publisher; and the Canadian commissioners are William A. Found, director of fisheries, Department of Marine and Fisheries, and John P. Babcock, assistant to the commissioner of fisheries, Province of British Columbia, chairman. The treaty provides for a "thorough investigation into the life history of the Pacific halibut" by the commission and requires that it make "recommendations as to the regulation" of this fishery. Under the direction of Will F. Thompson excellent progress has been made in the conduct of investigations. This includes the completion of the collection of all data on vessel landings of halibut since 1916. The tentative results indicate a heavy decline in the average catch per unit of gear and progressive depletion of the near-by banks. During 1925 more than 3,300 halibut were tagged, and 7.5 per cent of these were recaptured within 10 months. No directive migrations have been noted, the fish apparently moving as readily in one direction as in another. More than 6,800 halibut have been examined for age, the scales and otoliths have been saved, measurements made, and racial studies have been begun. During the current season special consideration is being given to the types of gear used and the effects of the use of hooks of various sizes. Spawning habits and larval life-history studies will be made

later. The investigative body is bending every effort to ascertain the need for changes in regulations as promptly as practicable.

To meet the United States share of the expenses of this commission, Congress appropriated $11,250 for the fiscal year 1925, $15,000 for 1926, and $28,500 for 1927. Like amounts have been put at the disposal of the Canadian representatives by the Dominion Government.

FISHERIES CONVENTION WITH MEXICO

Section III of the convention between the United States and Mexico to prevent smuggling, and for certain other objects, for which ratifications were exchanged at Washington on March 18, 1926, is devoted to the fisheries and contains the following provisions:

PREAMBLE

For the three following purposes, namely:

1. To facilitate the labors of the corresponding authorities in conserving and developing the marine life resources in the ocean waters off certain coasts of each nation;

2. To prevent smuggling in all kinds of marine products;

3. And to consider and to make recommendations with respect to the collection of the revenue from fish and other marine products.

The Government of the United States of America and Government of the United Mexican States agree as follows:

ARTICLE X

The high contracting parties agree that the waters dealt with under this convention shall be the waters off the Pacific coasts of California, United States of America, and Lower California, Mexico, including both territorial and extra-territorial waters, the latter being the westward extension of the former.

ARTICLE XI

The high contracting parties agree to establish within two months after the exchange of ratifications of this convention a commission, to be known as the International Fisheries Commission—United States and Mexico, that shall consist of four members, two to be appointed by each party. This commission shall continue to exist so long as this convention shall remain in force. Each party shall pay the salaries and expenses of its own members, and the joint expenses incurred by the commission shall be paid by the two high contracting parties in equal moieties.

The commission is hereby empowered to organize, to appoint its staff, and to fulfill the requirements of this section.

The commission shall make a thorough study of whatever subjects are necessary for carrying out the purposes of this section and shall submit recommendations unanimously approved by the commission to each Government for consideration and approval, covering whatever the commission deems necessary for the accomplishment of the purposes of this section. This study shall be undertaken within two months after appointment of the commission, and the recommendations shall be submitted as soon as practicable.

ARTICLE XII

The high contracting parties agree that if, after its study of conditions, the International Fisheries Commission recommends the adoption of regulations regarding the subjects set forth in the preamble and such regulations are approved by each Government, they shall become binding upon the authorities of both countries and shall be enforced by them.

The high contracting parties agree that the authorities of their respective ports shall refuse to permit any and all fish or marine products to enter the ports if brought into port from the waters specified in Article X, and if

the port authorities have reasonable grounds to believe that the master has obtained his cargo in violation of the laws of either of the high contracting parties, the regulations which may be adopted, or the provisions of this convention. Fines may be imposed in such cases or such cargoes thus illegally obtained may be declared forfeited and sold at auction to the highest bidder. Any proceeds therefrom shall be regarded as belonging to the high contracting parties in equal moieties and to the extent that may be determined by the high contracting parties to be necessary shall be made available for use in payment of the salaries and expenses of the commission as provided for in Article XI of this convention.

The International Fisheries Commission will inform and will keep informed all port authorities of both nations concerning any and all regulations which may have been established.

Article XV provides that "the convention shall come into effect at the expiration of 10 days from the date of its publication in conformity with the laws of the high contracting parties, and it shall remain in force for 1 year. If, upon the expiration of 1 year after the convention shall have been in force, no notice is given by either party of a desire to terminate the same it shall continue in force until 30 days after either party shall have given notice to the other of a desire to terminate the convention."

The members of the fisheries commission provided for under the convention are: For the United States, Henry O'Malley, United States Commissioner of Fisheries, chairman; N. B. Scofield, in charge, department of commercial fisheries, California fish and game commission. For Mexico: Jose R. Alcaraz, director of forests, game, and fisheries; and Carlos E. Bernstein, chief of the inspection service and of game and fisheries in the north and on the west coast of Lower California.

The first formal meeting of this commission was held at Los Angeles, Calif., on June 21, 1926. Provision was made for a complete survey, by experts, of general fisheries conditions in the territory covered by the treaty and the submission of definite results to the commission without delay.

For the United States' share of expenses in the fiscal year 1927 Congress has appropriated $30,000. The Mexican Government appropriated 178,000 pesos as its estimated share in the proposed work.

PRELIMINARY CONFERENCE ON OIL POLLUTION OF NAVIGABLE WATERS

A joint resolution of Congress (Pub. Res. No. 65, 67th Cong., H. J. Res. 297) approved by the President on July 1, 1922, setting forth the effects of oil dumped in navigable waters, requested the President to call a conference of "maritime nations with a view to the adoption of effective means for the prevention of pollution of navigable waters." This resolution includes reference to the destruction of ocean fisheries. On August 7, 1922, there was formed, with a representative of the State Department as chairman, an interdepartmental committee "to study the problem of oil pollution of navigable waters, with a view to preparing the way for the calling of an international conference as contemplated in the joint resolution." The Bureau of Fisheries has been represented in the deliberations of that committee, which continued to function up to the time of the Preliminary Conference on Oil Pollution of Navigable Waters, held in Washington, D. C., June 8 to 16, 1926, and has aided in

determining the effects of such pollution on the food fisheries in particular and aquatic life in general. The bureau also was represented on the advisory committee to the American delegates, which functioned during the preliminary conference.

The Governments participating in the preliminary conference were the United States, Belgium, British Empire, Canada, Denmark, France, Germany, Italy, Japan, Netherlands, Norway, Spain, and Sweden. The conference agreed that there has been a marked diminution of oil pollution since attention was first called to it, but that the evil is still serious in some waters, and that it can be dealt with satisfactorily only by international action: that the only vessels that need be taken into account, for the purposes of the conference, are seagoing vessels carrying crude, fuel, or disel oil in bulk as cargo or as fuel for boilers or engines; and that a mixture containing more than 0.05 of 1 per cent of crude, fuel, or Diesel oil should be regarded as constituting a nuisance. Through lack of agreement as to the extent and effects of pollution caused by the deposit of oily mixtures on the high seas at distances greater than 50 miles from shore, it was recommended that the Governments concerned provide for a system of prescribed areas in waters off their coasts beyond territorial limits within which classes of vessels prescribed shall not discharge crude, fuel, or Diesel oil or mixtures having an oil content in excess of 0.05 of 1 per cent. The complete report of the conference has been published by the Department of State.

NORTH AMERICAN COMMITTEE ON FISHERY INVESTIGATIONS

This committee is composed of representatives from the United States, Canada, Newfoundland, and France interested in stimulating and coordinating the programs of scientific research of the several Governments with respect to the fisheries of the western North Atlantic, the present productiveness of the fishing banks, and the trend of these important fisheries. The committee met at Montreal, Canada, on November 6, 1925, and at St. Johns, Newfoundland, on July 9, 1926. A plan has been developed for the collection of fishery statistics that will reveal the total annual production of cod and other fish in each district and by banks, as well as the fishing effort on these banks by which the annual changes in the fish stock may be judged. Excellent progress is being made in studies of the abundance and horizontal distribution of the cod, and the distribution, migration, and life history of the mackerel.

INTERNATIONAL PACIFIC SALMON INVESTIGATION FEDERATION

This federation, established in March, 1925, and including representatives from Federal and State fishery departments of the United States, including California, Oregon, Washington, and Alaska, and the Province of British Columbia, Canada, has undertaken the extensive tagging of salmon throughout this area.

Dr. Willis H. Rich is in direct charge of coordinating the work of the several agencies. Major investigations are being conducted to determine the proper escapement of fish to the spawning beds, to maintain the runs, and the return of fry from known escapements

Columbia River salmon-marking experiments in cooperation with Oregon State authorities have made possible a better understanding of the habits of the salmon and revealed the need for changes in fish-cultural methods involving the use of rearing ponds in holding salmon fry until the proper time for liberation. It is expected that through coordinated action under the federation greater progress will be achieved in the solution of these problems and at less cost.

FISHERIES LEGISLATION

INTERSTATE TRANSPORTATION OF BLACK BASS

Under an act of Congress (Pub. No. 256—69th Cong.) approved May 20, 1926, it is unlawful to engage in the interstate transportation of black bass "which have either been caught, sold, purchased, or possessed in violation of the laws of the State, Territory, or the District of Columbia wherein the delivery of such black bass for transportation is made or the transaction or the carrying thereof begins."

The black bass is primarily a sportsman's fish. The catch by the commercial fishermen amounts to about 1,000,000 pounds per annum. In cold weather, in northern waters, the fish collect in the deeper holes, where at certain times in their semidormant state they are easily taken by the net fishermen. In view of the growing popularity of angling, the well-known game qualities of the black bass, and its relative unimportance as a commercial food fish, it is believed that the law should be productive of good in keeping up the supply for the anglers.

ALASKA FISHERY LAW AMENDED

The Alaska fisheries act of June 6, 1924, was amended by the act of June 18, 1926, which reenacts section 1 of the act of 1924, with the addition of the following language: "*Provided further*, That the Secretary of Commerce is hereby authorized to permit the taking of fish or shellfish, for bait purposes only, at any or all seasons in any or all Alaskan Territorial waters." This addition to the law enables the improvement of conditions under which halibut fishermen heretofore have secured herring for bait, and at the same time permits adequate conservation of the herring fishery.

UPPER MISSISSIPPI RIVER WILD LIFE AND FISH REFUGE ACT

This act, which was approved June 7, 1924, provides in part that water areas acquired under the terms of the act, to such extent as the Secretary of Commerce may by regulations prescribe, be used as a refuge and breeding place for fish and other aquatic animal life or for the conduct of commercial fishing. For the construction of buildings and ponds, for equipment, maintenance, operation, etc., Congress appropriated $25,000. Acting under this authority, this bureau has been assembling boats and other equipment that will be needed in the work. The difficulties encountered by the Secretary of Agriculture in securing suitable areas under the terms of the act has retarded the beginning of operations.

FISH HATCHERIES

During the first session of the Sixty-ninth Congress there were introduced 36 bills for the establishment of fish-cultural stations, distributed among 23 States. Many of these bills provide for hatcheries in sections that are in need of aid to replenish the depleted supply of fish. Only two auxiliary stations were authorized—one in Georgia and one in Colorado.

Only two of the bills submitted provided for the establishment of stations for the propagation of marine fishes. The bureau has opposed the establishment of additional marine stations, as it is believed that before such stations are authorized careful scientific investigations should be made. These should determine the practicability of (1) hatching the species common to the region, (2) obtaining eggs in sufficient quantities to warrant the investment, and (3) assurance that such operations will yield results commensurate with their cost. It is believed that, in general, the application of proper conservation measures, the saving of immature and undersized fish from destruction, and other proper regulatory practices will accomplish more in maintaining a fishery for marine species than will the establishment of a marine hatchery.

In the present marine stations in the New England area the eggs are salvaged from the catch of the commercial fishermen. In so far as practicable spawn takers accompany the fishing vessels to the fishing grounds, strip the ripe fish in the market catch, and fertilize and return the eggs to the water on the natural spawning grounds.

The output of these marine stations represents about 75 per cent of the total output by the bureau, produced at a cost of less than 7.25 per cent of the total outlay from all sources used in the bureau's fish-cultural work. The cost of this marine work was less than $14 per million of eggs and fry produced.

STATE LEGISLATION

The States are revealing a growing interest in the enactment of more adequate legislation for the maintenance of their fisheries, as evidenced by the character of legislation approved. For example, New York State has amended its conservation law by forbidding the purchase, sale, or offering for sale of 10 important food fishes measuring less than certain prescribed lengths. This measure was sponsored by the commercial fisherman to lessen the destruction of undersized or immature fish. Virginia has increased the protection afforded the blue crab by more specifically defining the peeler crab, increasing the size limits on hard crabs, and prohibiting the taking of egg-bearing female crabs (sponge crabs) at any season.

One of the most constructive measures the States could provide at this time would be one for the regular and continuous collection of fishery statistics along uniform lines, so that the statistics of one State would be comparable with those of another. Such measures are highly essential for revealing the trend and condition of important fisheries.

SESQUICENTENNIAL EXHIBITION AT PHILADELPHIA

A joint resolution of Congress (Pub. Res. No. 62—68th Cong.) approved March 3, 1925, provided for the cooperation of the United States in the Sesquicentennial Exhibition commemorating the signing of the Declaration of Independence. From the funds assigned to the Department of Commerce the bureau was given an allotment of $7,500, and floor space in the Palace of Transportation, 50 by 60 feet, was assigned from space set apart for the exhibit of the department.

In so far as practicable, the activities of the bureau have been presented in an attractive manner. A set of 24 colored transparencies in a specially designed case is used for portraying the work of each division. Special exhibits include the following: Fishing tackle (two cases), nutrition of fish and shellfish, by-products (menhaden), shark and shark leather, artificial pearls and other products using fish-scale essence, oyster investigations, destructiveness of shipworms, models of food fishes and fishing vessels, oceanographic equipment, fur-seal and fox skins, balanced aquaria, hatching troughs, and a pool.

REBUILDING VESSEL SERVICE

In recent years the bureau has been prevented from carrying on investigations at sea and from providing a proper Alaskan patrol because of antiquated or inadequate vessels. Among the obsolete vessels that have been put out of commission are the *Albatross* (built in 1883), *Fish Hawk* (built in 1879), and *Halcyon*. For Atlantic coast work the bureau has obtained from the Navy Department the ocean tug *Patuxent*, renamed *Albatross II*. This vessel, built in 1909, is well adapted for oceanographic research on the high seas and will make it possible to take up such problems as the study of the western Atlantic fishing grounds, which has been delayed because of the inadequacy of the older vessels. The *Brant*, a new vessel 100 feet long, powered with a 225-horsepower full Diesel engine, represents an important addition to the Alaska patrol fleet.

AQUICULTURE

The development of aquiculture as an auxiliary source of food is becoming recognized as of highly potential importance. Involved in this science of increasing the productiveness of water areas are questions of climate, hydrography, recreation, reclamation, and others. We should be able to determine whether a given area is more valuable for water crops than if reclaimed and used for agriculture. We need to know to what water crops a given area is best suited and how to produce the maximum output of which that area is capable. In this country the science of agriculture is highly specialized, while but little attention has been given to the science of aquiculture in comparison with that given in European countries. Sufficient progress has been made to warrant the belief that, on the average, an acre of water may produce as much protein food as an acre of land.

In the past our interest has been chiefly in the field of fish culture, largely prosecuted by Federal and State agencies; but here more attention has been given to the mechanics of operations and the taking of a huge volume of eggs than to determining the effects of such operations. The condition is changing rapidly, however, and greater interest is being shown in simulating natural conditions while obviating their drawbacks, in carrying the fish through to the fingerling stage, in determining the best foods for the young, and means for combating diseases, in developing a superior brood stock, and in many other lines of investigation.

Commercial fish-culturists now supply about $200,000 worth of trout eggs and market their surplus fish for food at fancy prices. The annual output of goldfish and other ornamental varieties is probably not less than 20,000,000, with an estimated value of $350,000.

At the present time oyster farming is being conducted on a larger scale than is any other aquicultural pursuit, with more than 150,000 acres of oyster grounds from Massachusetts to Florida under lease, not all of which is under cultivation. Considering the adaptability of our coastal waters to such use, it is conceivable that we may easily double or treble our present annual harvest of nearly 18,000,000 bushels with the development of this science. One of the most interesting recent developments is that initiated by the Secretary of Commerce providing for the development of cooperative fish nurseries, referred to elsewhere in this report.

During the past year the bureau has greatly expanded its operations in this line. It is now operating an experimental trout hatchery at Holden, Vt.; its pond system at the Fairport (Iowa) station is being utilized in experiments to determine the productiveness of water areas and means for increasing them; and arrangements are being made to develop the pond areas acquired under the Mississippi wild life and fish refuge act. State agencies and private organizations such as the National Research Council are evincing increased interest in developing the science of aquiculture.

ALASKA FISHERIES SERVICE

ADMINISTRATION OF FISHERY LAWS AND REGULATIONS

Alaska fishery activities in 1925 were carried on along the same general lines as in the previous season, which was the first in which the new law of June 6, 1924, giving the Secretary of Commerce greater authority to limit or prohibit fishing, as deemed necessary for conservation purposes, was in effect. As a result of experience and observation in 1924, some changes were made in the regulations for 1925, chiefly as to closing additional areas where overfishing occurred. Other modifications included the extension of closed periods and further limitations upon fishing apparatus. The Commissioner of Fisheries spent much of the active salmon fishing season in Alaska to note conditions and to recommend such amendments to the regulations as appeared necessary. Results were satisfactory in regard to better observance of the laws and regulations as well as in increased escapements of fish to the spawning grounds.

A general revision of the regulations, to be effective in 1926, was issued by the Secretary of Commerce under date of December 5, 1925. Among the new features were the requirement of a distance interval of 1 mile between traps in the southeastern Alaska area, south of 58° north latitude, and also in a part of the Alaska Peninsula area; the closing of 23 localities in addition to the 76 previously closed; the adding of the Kuskokwim River waters to the Yukon area, in which all commercial fishing for export from Alaska is prohibited; and the placing of additional restrictions on herring and clam fisheries. Further limitations were imposed on the operation of certain kinds of apparatus in various areas.

The patrol for the protection of the fisheries of Alaska and the enforcement of the law and regulations was expanded in 1925. Altogether 13 regular and 132 temporary employees, exclusive of those on the bureau's 10 vessels and the 11 chartered for patrol operations in the various districts, were identified with this work. A number of small launches also were used.

Special attention was given to marking the limits of all closed areas and the 500-yard zone off the mouths of salmon streams. This was necessary by reason of the decision of the United States Circuit Court of Appeals in June, 1925, to the effect that it was not unlawful to operate a trap or to fish within 500 yards of a stream unless the mouth had been marked officially. All closed areas were marked, and the mouths of nearly all salmon streams had been marked before the opening of the 1926 fishing season.

ALASKA SALMON HATCHERIES

At the Government hatcheries at Afognak and on McDonald Lake 50,680,000 red-salmon eggs were collected in 1925. The two privately owned salmon hatcheries operated under the provisions of the act of June 26, 1906, collected 37,160,000 red-salmon eggs.

The hatcheries of the Alaska Territorial Fish Commission at Ketchikan, Cordova, and Seward handled 25,890,844 salmon eggs taken in 1925. Included in this number were 2,000,000 chinook eggs transferred from the State of Washington to the Ketchikan hatchery. Other species handled were reds, humpbacks, and chums.

SPECIAL STUDIES AND INVESTIGATIONS

In 1925 salmon ascending streams to spawn were counted at Anan Creek in southeastern Alaska and in Chignik River, Karluk River, and two streams tributary to Alitak Bay waters, in central Alaska.

Salmon tagging was carried on in southeastern Alaska and at Port Moller, Alaska Peninsula. Two thousand reds were tagged at Port Moller, and 13,645 coho, chum, humpback, and red salmon were tagged in various localities in southeastern Alaska. This was a continuation of the studies of migration routes begun in 1922. The study of the clam fishery of central Alaska was continued, and investigations of the herring fishery were begun in 1925.

In the fall of 1925 special attention was given to the collection of data on the escapement of spawning salmon. In southeastern Alaska, as a whole, the escapement was satisfactory, demonstrating

the effectiveness of the restrictions imposed by the regulations. Conditions were generally satisfactory in the Prince William Sound region also, with the exception of the Copper River, where both the run and escapement of red salmon were small. The escapement in the Cook Inlet district as a whole was regarded as satisfactory. In the Alaska Peninsula area the escapement was fair, as compared with the run that was regarded as below average. Conditions in the Bristol Bay area were unsatisfactory. As soon as it was realized that the run was small, regulations were promulgated discontinuing commercial fishing forthwith, but a later inspection of the spawning grounds of the eastern side of Bristol Bay showed a very poor escapement. Conditions were considerably better in the Nushagak Bay tributaries, where there were indications of a good escapement.

EXTENT OF THE ALASKA FISHERIES

Although there was a decreased production of salmon in Alaska in 1925, the industry showed a slightly larger investment, and more persons were employed. The catch of salmon in southeastern Alaska increased 3.6 per cent, while that in the central district declined 45 per cent and in western Alaska 31 per cent. The smaller catch in central Alaska was due to the smaller run of humpback salmon that occurs in alternate years; and the decline in western Alaska resulted chiefly from the small take in Bristol Bay, where commercial fishing was ordered discontinued at an earlier date to permit a proportionately larger escapement of spawning salmon. The decrease in the catch of salmon for Alaska as a whole was about 19 per cent. A comparison of Alaska salmon canning operations in 1924 and 1925 follows.

Item	1924	1925	Percentage of increase (+) or decrease (—)
Canneries operated	130	129	—0.77
Cases of salmon packed	5,294,915	4,459,937	—15.77
Value	$33,007,135	$31,989,531	—3.08
Persons employed	20,107	21,805	+8.45
Cases of salmon packed, by species:			
Coho	183,601	161,010	—12.30
Chum	1,028,488	1,078,680	+4.88
Humpback	2,601,283	2,110,593	—18.86
King	33,648	49,978	+48.53
Red	1,447,895	1,059,676	—26.81
Number of salmon caught	79,477,600	64,246,391	—19.16

Other salmon products were: Mild cured, 5,217,600 pounds, valued at $1,085,466; pickled, 629,600 pounds, valued at $84,731; fresh, 2,620,017 pounds, valued at $223,907; frozen, 2,572,623 pounds, valued at $170,663; dry salted, dried, and smoked, 1,048,045 pounds, valued at $126,465; fertilizer, 1,432,625 pounds, valued at $41,807; and oil, 40,680 gallons, valued at $18,330. The total value of these minor products in 1925 was $1,751,369. The value of similar products in 1924 was $1,786,369.

The products of the herring fishery were as follows: Bait, 7,086,840 pounds, valued at $39,426; Scotch cured, 33,925,975 pounds, valued at $2,270,577; Norwegian cured, 365,225 pounds, valued at $22,969;

spiced, for food, 10,200 pounds, valued at $1,200; bloaters, 190,575 pounds, valued at $7,660; dry salted, 677,705 pounds, valued at $19,974; canned, 38 cases, valued at $150; fertilizer, 17,172,027 pounds, valued at $491,448; and oil, 2,351,152 gallons, valued at $999,045. The total value of herring products was $3,852,449, as compared with $2,458,370 in 1924.

The halibut industry produced 3,249,229 pounds of fresh fish, valued at $302,000, and 7,722,422 pounds of frozen fish, valued at $582,383, a total production of 10,971,651 pounds, valued at $884,383.

The shore-station cod fishery yielded 2,853,942 pounds of products, valued at $128,803. The whaling industry produced oil, fertilizer, pickled meat, and carcasses valued at $624,959.

The pack of clams amounted to 75,279 cases, valued at $492,051. The output of shrimps was 519,535 pounds, valued at $207,315. Crab products were valued at $53,357. The output of trout was 53,152 pounds fresh, frozen, and pickled, valued at $6,137. There were also produced 1,042,525 pounds of sablefish, valued at $44,836; 23,420 pounds of smelts, valued at $2,342; 10,835 pounds of flounders, valued at $108; 20,643 pounds of rockfishes, valued at $390; 3,293 pounds of red rockfish, valued at $100; and 30,736 pounds of "lingcod" valued at $615.

The total value of the manufactured fishery products of Alaska in 1925 was $40,038,745. The value of the catch to the fishermen was approximately $9,860,000.

The entire Alaska fishery industry gave employment to 27,685 persons and represented an investment of $67,077,495.

The extent and condition of the Alaska fisheries in 1925 and of the activities of the bureau under the laws and regulations for the protection of the fisheries are covered in detail in the annual report of the Alaska service for that year.[2]

ALASKA FUR-SEAL SERVICE

GENERAL ACTIVITIES ON THE PRIBILOF ISLANDS

The Pribilof Islands in Bering Sea, Alaska, are the breeding grounds of the North American fur-seal herd and the chief source of the world's supply of fur-seal skins. This herd numbers more than 700,000 animals, contrasted with which recent reports indicate that the Robben Island herd belonging to Japan contains about 29,000 animals and the Russian herd at the Commander Islands about 19,000 animals. Other much smaller herds are found off Uruguay, the west coast of South America, in the vicinity of the Cape of Good Hope, and thinly scattered among a few islands of the Antarctic.

In the conduct of operations at St. Paul and St. George Islands, seal killings are limited to surplus males and are confined almost wholly to animals three years of age. The skins are cured and pre-

[2] Alaska Fishery and Fur-Seal Industries in 1925. By Ward T. Bower. Bureau of Fisheries Document No. 1008.

pared for shipment to St. Louis, Mo., where they are made ready for market and sold at auction. The fur-seal convention of 1911 stipulates that Great Britain and Japan shall each receive 15 per cent of the sealskins taken annually at the Pribilof Islands, but through arrangement with those nations the matter is handled by remittance to each of 15 per cent of the net proceeds of skins sold.

Sealing work at the Pribilofs during the year was along the usual lines. Approximately half of the skins taken on St. Paul Island were blubbered before being salted, and the matter of adequate breeding reserves received attention. As to construction and permanent improvement activities in 1925, particular mention may be made of the new water-supply systems put in operation and the excellent progress made in the replacement of old dwellings for natives and white employees on both islands. Also, considerable road construction work was done on St. Paul Island.

The 325 native inhabitants at the Pribilofs are, in effect, wards of the Government. They engage in sealing and other work of the two communities. Cash payments of 75 cents for each sealskin and $5 for each fox skin taken are made to the natives, but their main compensation is in shelter, food, clothing, schools, and medical attention furnished without cost by the Government. Activities on the Pribilofs are supervised by a staff of white employees.

Through cooperation of the Navy Department the annual supplies and a number of employees of the bureau were transported on the U. S. S. *Vega* from Seattle, Wash., to the Pribilof Islands. Employees were furnished transportation on vessels of the United States Coast Guard as well. Acknowledgment is made of the particularly constructive cooperation of both the Navy and the Coast Guard in connection with the bureau's fur-seal activities.

SEAL HERD

Computations showed a total of 723,050 fur seals in the herd on August 10, 1925, an increase of 25,892 animals over the figures for the corresponding date in 1924.

TAKE OF SEALSKINS

In the calendar year 1925, 19,860 fur-seal skins were taken on the Pribilof Islands, of which 15,082 were secured on St. Paul Island and 4,778 on St. George Island.

MARKING OF RESERVED SEALS

As in the previous season, a reserve of 3-year-old male seals was marked by shearing a patch of fur from the top of the head. On St. Paul Island 7,424 were so marked and on St. George Island 1,130. In addition, on St. George Island 800 3-year-old males were given a permanent brand with a hot iron to enable recognition and observation in future years. This makes a total of 9,354 reserved in 1925. A temporary mark also was put on 2,918 4-year-old and 2,730 5-year-old males.

The increase in the size of the seal herd in recent years makes it necessary to reserve each year a considerably larger number of young males for future breeding purposes than the minimum of 5,000 required by law. Reserves are made of 3-year-old males for the reason that commercial killings of seals, aside from the small number incidentally taken, are made from this class. The actual reserve of 3-year-old males in 1925 was, of course, larger than the number marked and released because, as is well known, not all the animals in this class are taken up in the drives.

SALES OF SEALSKINS

In the fiscal year 1926 two public auction sales of fur-seal skins taken on the Pribilof Islands were held at St. Louis, Mo. The first was on September 24, 1925, when 8,298 black-dyed and 888 brown-dyed skins were sold at a gross price of $335,369.50. In addition, 60 brown-dyed and 22 raw salted Japanese sealskins sold for $578.50 and one black-dyed confiscated sealskin brought $20. At the second sale on May 24, 1926, 11,207 black-dyed, 3,220 brown-dyed, and 175 miscellaneous skins were sold for $430,748. At this time there also were sold seven confiscated sealskins and one skin from a seal that died at the Steinhart Aquarium. These eight skins brought a total of $8. The Secretary of Commerce authorized the further sale of 691 sealskins, the sum realized being $21,267.63.

The Japanese sealskins sold at the September sale were the United States Government's share of skins taken by the Japanese Government on Robben Island in 1923. The 94 skins that were this Government's share of the 1924 take on Robben Island and 87 skins from the take in 1925 have been received and will be sold in due time.

FOXES

Satisfactory progress was made in the systematic feeding of foxes on both St. Paul Island and St. George Island through the winter of 1925–26. The shortage of natural food on St. Paul Island during the winter and the difficulties attending systematic feeding heretofore have prevented any great development of the herd on that island.

At the public auction sale on September 24, 1925, there were offered 341 blue and 28 white fox skins, these being part of the take in the winter of 1924–25. The blue skins brought $16,579 and the whites $1,040. The remainder of the skins taken in the winter of 1924–25 will be sold later. In the season of 1925–26, 725 skins were secured, of which 67 blues and 19 whites came from St. Paul Island and 638 blues and 1 white were taken on St. George Island. During foxing operations 211 males and 155 females were marked and released for breeding purposes on St. Paul Island, and 216 males and 215 females on St. George Island. In addition to the animals marked there are those never captured, which considerably increase the breeding stock.

FUR-SEAL SKINS TAKEN BY NATIVES

During the 1925 spring migration of the fur-seal herd Indians took 1,765 skins in waters off the coast of Washington and 279 skins in southeastern Alaska waters, all of which were duly authenticated. Through the courtesy of the Department of the Interior, the superintendent of the Neah Bay Indian Agency was authorized to authenticate skins taken by Indians of the reservations in the State of Washington. A representative of the bureau at Sitka, Alaska, authenticated the skins taken in that vicinity. A considerable number were taken by natives of British Columbia also.

FUR-SEAL PATROL

Vessels of the United States Coast Guard maintained the customary patrol for the protection of the fur-seal herd in its annual migration through waters off the Pacific Coast States, British Columbia, and Alaska. The bureau's vessels also took part in the patrol, particularly in southeastern Alaska, during the time sealing operations were being carried on by Indians in that district.

PROTECTION OF SEA OTTERS, WALRUSES, AND SEA LIONS

Announcement was made that the Federal law absolutely prohibits the killing of sea otters in Alaska except under authority of the Secretary of Commerce. It was stated that no such authority has been granted by the Secretary, and that therefore the prohibition of the law continues in force. A new edition of the circular containing the regulations affecting walruses and sea lions in Alaska was issued as of May 1, 1926, which extends the closed season on these animals for two years.

PROPAGATION AND DISTRIBUTION OF FOOD FISHES

FISH-CULTURAL OPERATIONS

Each year it becomes necessary to carry over until the next year a large number of applications for fish for stocking waters, due to the fact that the resources of the division of fish culture are taxed to the limit to supply the general public with fish. At the end of the fiscal year 1926 approximately 5,000 unfilled applications were on hand, which constitute a heavy draft on next season's production. It is quite evident that the general public is taking more and more interest in fishing, especially for bass and trout. The bureau has endeavored to meet this demand by increasing the efficiency of several of the hatcheries, where additional trough room and the enlargement of ponds make it possible to produce more fish, especially larger fingerlings, for distribution. At many of the stations the water supply is very limited, which, together with the unfavorable topography of the grounds, makes it impracticable to construct additional ponds. It will be necessary, therefore, to resort to other methods to produce larger fingerling fish in greater numbers if the output of the stations is to be increased.

COOPERATIVE FISH NURSERIES

At the principal trout hatcheries the congested condition during the spring months, just after the eggs have hatched, has been relieved to a large degree by the transfer of small fish to cooperative nurseries after they have been feeding for from four to six weeks. The nurseries are furnished by fish and game organizations working in cooperation with the bureau. The organizations supply troughs, ponds, fish food, and all equipment, including men to care for and feed the fish. At these nurseries the fish are held in troughs until they are approximately 2 inches in length, when they are placed in the nursery ponds and held until fall for distribution. Fifty per cent of the fish thus produced are turned over to the bureau for the purpose of supplying applications that it has from that region, and the other 50 per cent is given to the club for stocking local waters.

The cooperative fish nursery arouses the interest of the public in the production and protection of fish, brings financial support from those most interested, reduces the bureau's distribution costs, insures the rearing of a larger number of fry to the fingerling sizes, simplifies the distribution of such fish, and promises to be one of the greatest advances made in recent years to keep our streams stocked with trout.

The production of bass always has been fraught with difficulties not fully understood by the general public. Sometimes applications are received for 1,000,000 bass. At most of the bass hatcheries not more than 5 to 8 acres are used for ponds that usually average from one-third to one-fourth acre in area. It is impossible to produce large fingerling bass and other warm-water fishes in such small areas, as they are wide rangers and require considerable pond room to become large fish. The young fish must have microscopic food, such as daphnia. At a later stage of development the stronger fish prey upon the weaker ones. For organizations with facilities for rearing fish in ponds of 10 to 15 acres a cooperative plan has been suggested. Larger areas would be suitable if the water supply could be so controlled as to prevent flooding and in the fall of the year drained to remove the small fish. The Bureau of Fisheries is not in a position to supply brood stocks for such projects. It can render material aid to such organizations by supervising the construction of the ponds and the general work of rearing and distributing the fish. Many organizations may find it possible to set aside suitable areas for bass culture that can be operated under Government supervision.

Commercial species of fish were propagated on a large scale at the stations located on the Atlantic and Pacific coasts and throughout the Great Lakes region. Eggs were collected from fish caught by the commercial fishermen or experienced spawn takers furnished by the bureau, and were sent to the hatcheries to be incubated. The resulting fry were released on natural spawning grounds. The bureau has been aided greatly in this work by many of the States.

Summary, by species, of the output of fish and eggs during the fiscal year ended June 30, 1926

Species	Eggs	Fry	Fingerlings	Total
Catfish		1,400,000	30,964,500	32,364,500
Buffalo fish		105,315,000	11,258,600	116,573,600
Carp		54,500,000	40,349,500	94,849,500
Sand perch			5,000	5,000
Shad		9,143,800		9,143,800
Glut herring		55,000,000		55,000,000
Whitefish	8,320,000	200,024,000		208,344,000
Cisco	10,080,000	85,000,000		95,080,000
Salmon:				
Chinook	11,284,600	800,000	50,837,300	62,921,900
Chum		18,163,500		18,163,500
Silver	211,000	4,555,800	5,134,900	9,901,700
Sockeye	150,000	9,795,800	64,681,000	74,626,800
Humpback		1,753,500	90,000	1,843,500
Steelhead	1,133,800	1,029,500	4,324,500	6,487,800
Atlantic	100,000	776,000	125,600	1,001,600
Landlocked	383,900	432,100	270,600	1,086,600
Trout:				
Rainbow	2,827,500	1,540,800	3,621,100	7,989,400
Black-spotted	8,917,800	1,473,200	3,868,400	14,259,400
Loch Leven	3,894,500	616,000	2,987,000	7,497,500
Lake	1,590,000	29,957,100	269,300	31,816,400
Brook	874,000	2,951,000	10,937,100	14,762,100
Silver			232,700	232,700
Grayling		4,823,800		4,823,800
Pike and pickerel			465,800	465,800
Mackerel		2,067,000		2,067,000
Crappie			26,741,600	26,741,600
Bass:				
Largemouth black		919,300	1,394,500	2,313,800
Smallmouth black		810,000	161,700	971,700
Rock			66,100	66,100
Warmouth			4,900	4,900
White			42,500	42,500
Sunfish			27,746,700	27,746,700
Pike perch	82,745,000	130,960,000	27,200	213,732,200
Yellow perch	7,500,000	122,501,000	2,704,400	132,705,400
Sheepshead			300	300
Fresh-water drum			130,300	130,300
Cod	429,338,000	554,629,000		983,967,000
Haddock	114,051,000	31,895,000		145,946,000
Pollock		428,788,000		428,788,000
Winter flounder	53,735,000	2,334,322,000		2,388,057,000
Miscellaneous fishes			9,851,600	9,851,600
Total	737,136,100	4,195,942,200	299,294,700	5,232,373,000

RELATIONS WITH STATES AND FOREIGN GOVERNMENTS

The bureau's principal cooperative work was the exchange of fish and eggs with various State authorities and aiding the States in every way possible to secure better enforcement of the laws for protecting fish. By exchanges of applications and facilities for incubation and distribution economies have been effected. The bureau has continued to furnish the States the services of its experienced men to aid in locating hatcheries and also in making inspections and suggestions for improvements to State hatcheries. It also has continued to exchange eggs with the Canadian fisheries authorities, receiving Atlantic-salmon eggs in exchange for trout eggs of other species.

Allotments of fish eggs to State and Territorial fish commissions, fiscal year 1926

State and species	Number
Arizona: Black-spotted trout	52,000
California: Black-spotted trout	354,000
Colorado: Loch Leven trout	336,000
Hawaii:	
Chinook salmon	15,000
Rainbow trout	25,000
Steelhead salmon	43,000
Idaho:	
Black-spotted trout	500,000
Rainbow trout	50,000
Illinois:	
Black-spotted trout	10,000
Lake trout	50,000
Loch Leven trout	25,000
Rainbow trout	51,800
Silver salmon	200,000
Iowa: Rainbow trout	51,300
Maine:	
Atlantic salmon	100,000
Lake trout	100,000
Maryland: Rainbow trout	104,000
Massachusetts:	
Loch Leven trout	100,000
Rainbow trout	25,000
Michigan: Cisco	8,000,000
Missouri: Loch Leven trout	100,000
Montana: Loch Leven trout	431,500
Nevada: Black-spotted trout	50,000
New Hampshire: Chinook salmon	75,000
New Mexico:	
Black-spotted trout	600,000
Loch Leven trout	500,000
New York:	
Black-spotted trout	15,000
Lake trout	515,000
Steelhead salmon	25,000
North Carolina:	
Glut herring	25,000,000
Lake trout	50,000
Loch Leven trout	50,000
Rainbow trout	409,000
Oklahoma: Yellow perch	7,500,000
Oregon:	
Black-spotted trout	1,000,000
Chinook salmon	8,136,600
Steelhead salmon	510,000
Pennsylvania:	
Cisco	2,080,000
Loch Leven trout	500,000
Whitefish	5,470,000
South Dakota: Loch Leven trout	500,000
Utah:	
Black-spotted trout	100,000
Brook trout	274,000
Vermont:	
Lake trout	125,000
Steelhead salmon	100,000
Washington:	
Black-spotted trout	1,825,000
Humpback salmon	115,000
West Virginia: Loch Leven trout	150,000
Wyoming:	
Black-spotted trout	485,000
Lake trout	25,000
Loch Leven trout	300,000
Rainbow trout	250,000
Total	67,458,200

Shipments of fish and eggs to foreign countries, fiscal year 1926

Country and species	Eggs	Fish
Argentina: Top minnows		2,000
Brazil:		
Bream		100
Crappie		75
Rock bass		100
Canada: Loch Leven trout	852,000	
Colombia: Steelhead salmon	25,000	
Dominican Republic: Top minnows		15,000
Italy: Steelhead salmon	50,000	
Japan: Whitefish	2,700,000	
Switzerland: Rainbow trout	72,000	
Total	3,699,000	17,275

PROPAGATION OF PACIFIC SALMONS

Fish-cultural operations on the Pacific coast have been directed principally to the rearing of young salmon fry in nursery ponds so that larger fingerlings might be produced for stocking purposes. The sentiment among fish-culturists and commercial fishermen is greatly in favor of this work. Three and four inch salmon undoubtedly are superior for stocking purposes to fry that have just absorbed the food sac.

It is thought that the enforcement of regulations in Alaska for the protection of salmon will be of great aid in maintaining the salmon runs. The introduction of some form of lift to pass the fish over high-power dams uninjured should be another important factor, and various experiments are being conducted with fish elevators. Preventing the access of the salmon to their spawning grounds will

mean the extinction of the species. Attempts have been made also to pen and hold the fish until their spawning period.

As rapidly as possible hatching facilities at the stations are being enlarged. One of the most important difficulties in the bureau's work is to provide a food supply for the young fish, and as far as practicable the spawned-out salmon are prepared and preserved for feeding the young fish.

The Yes Bay (Alaska) station released approximately 6,000,000 young salmon in Lake MacDonald during the month of June. In the Washington field the run of steelhead salmon was much larger than for several years. An experiment will be carried out at Ozette Lake, Wash., for the purpose of determining if sockeye salmon can be ripened in an inclosure, and 1,000 adult fish will be held for this purpose in a pen in the river below the lake.

COMMERCIAL FISHES OF THE GREAT LAKES

Operations to collect whitefish, cisco, lake trout, and pike perch eggs were conducted at stations on the Great Lakes during the season. Early in the fall adverse weather made it difficult for the commercial fishermen to operate their nets, which in turn greatly curtailed the collection of eggs, as the hatcheries must depend upon the fish obtained from the commercial fishermen for eggs. Owing to local demands, few eggs were collected in the Canadian fields. If some form of agreement can be effected between the bureau and the Canadian Government it is believed that large numbers of whitefish and cisco eggs may be obtained for the Cape Vincent station. Owing to the fact that a large percentage of the whitefish caught in the vicinity of Alpena and Charleviox, Mich., are not in spawning condition when taken in the nets of the fishermen, arrangements will be made to pen the fish in certain fields so that their eggs may be taken when ripe. It is hoped that a plan may be developed whereby closer cooperation with the commercial fishermen will result in the taking of a larger number of eggs of market fish.

MARINE SPECIES OF THE NORTH ATLANTIC COAST

The bureau operates three marine hatcheries on the Atlantic coast—Boothbay Harbor, Me.; Gloucester, Mass.; and Woods Hole, Mass.—the principal species handled being cod, haddock, pollock, and winter flounder. During the spawning season, when the commercial fisheries fleet operates in the vicinity of the hatcheries, experienced spawn takers are placed on board the vessels, or in some instances the crew collects the eggs from the spawning fish. These eggs are sent to the various hatcheries, where they are incubated and the resulting fry released on natural spawning grounds. Were it not for the service performed by the bureau the eggs would be lost when the fish are dressed and sent to market.

Frequently such fishing boats are out for from 5 to 10 days, making it impracticable to hold the eggs and deliver them to the hatcheries, and they are then fertilized and planted at sea. If funds are available, this conservation work will be extended. This method of handling fish eggs has been undertaken in various fields where

it is not practicable to send the eggs to the hatchery. This applies to the buffalo fish work in Louisiana and at points on the upper Mississippi River. The marine hatcheries are so situated that they can be operated at minimum cost, and the output, therefore, is obtained at a very low cost per million when compared with the collection of eggs of the salmon, whitefish, and other important commercial species. At the Woods Hole station the codfish are purchased alive from commercial fishermen and taken to the hatchery, where they are placed in a large pool and permitted to spawn naturally. The eggs being bouyant, they are collected in screen boxes as they pass out of the pool to the water supply. After spawning the adult cod are released in the ocean.

MIGRATORY FISHES OF THE ATLANTIC COAST

The most important species in this group is the shad, which is having a hard struggle to maintain itself in northern rivers. The catch of shad has been falling off at an alarming rate for a number of years. At the present time the bureau is operating but one shad hatchery, located at Bryans Point, Md., on the Potomac River. The work on Albemarle Sound can not be considered, as shad propagation is conducted only at times when certain seine fisheries are in progress. To a large extent weather conditions interfere with the runs of shad or the number of eggs obtained at a given hatchery. The dumping of trade wastes and the pollution of streams apparently further the decline of the shad fisheries. Ten or fifteen years ago shad were caught in the vicinity of Washington, D. C.; now very few, if any, shad are caught north of Mount Vernon. It appears that it will be necessary for the States interested in the maintenance of shad to take drastic measures in regard to their protection. There should be a yearly and weekly closed season with a limitation on net fishing in specified waters. Certain areas should be set aside by the States as natural spawning grounds for shad and fishing in those areas prohibited. Were such methods adopted, it is believed that the shad would maintain themselves through natural reproduction.

During the past season considerable attention was given to the reestablishment of a temporary hatchery on the Roanoke River at Weldon for the collection of eggs of the striped bass. If suitable facilities can be obtained, it is very probable that this work will be resumed.

SALVAGING OF FOOD FISHES FROM OVERFLOWED LANDS

During June, 1925, the upper Mississippi River was very low, which prevented the adult fish from reaching spawning grounds in the marginal lakes, with the result that the number of fish rescued, while greater than during the previous year, was somewhat below normal. If normal rains do not occur in July and August, the water level of the river frequently drops so rapidly that many of the lakes dry before the bureau's crew can reach them. On the other hand, heavy rains during the summer months cause the lakes to maintain their level, when dense growths of aquatic plants make it almost impossible to haul seines. No attempt was made to

salvage fishes in Louisiana or in the vicinity of Friars Point, Miss. The river did not reach a sufficiently high stage to overflow the borrow pits. During the season many of the fish returned to local waters and were inoculated with the glochidia of fresh-water mussels.

PROPAGATION OF FISHES IN INTERIOR WATERS

Very notable results were attained in the Meadow Creek (Mont.) field in the collection of the eggs of the Loch Leven trout. The large collections made would seem to indicate that the waters of Montana are very well suited to this species. Advantageous exchanges of eggs of other species of trout were made with many State fish and game commissions. In the Colorado and Utah fields good collections of brook-trout eggs were obtained. Virtually all of the bureau's fish-cultural stations that handle trout have enlarged their facilities so that greater numbers of fish may be held until they reach the large fingerling stage before shipment. Fish-cultural operations in the Yellowstone Park field were somewhat curtailed on account of prevailing high waters during the spawning season of the black-spotted trout. Many apparently spawned on the beaches and did not ascend the streams as usual.

COMMERCIAL FISHERIES AND FISHERY INDUSTRIES

REVIEW

The number of persons engaged in the fisheries and fishery industries of the United States and Alaska exceeds 191,000; the investment amounts to about $202,000,000; and the annual sales of fishery products by fishermen is about 2,881,000,000 pounds, valued at about $97,000,000; the output of canned fishery products has an annual value of over $80,000,000; and the production of by-products is valued at about $15,000,000.

Conditions in the fisheries during 1925 compare very favorably with those of the past few years. Vessel landings at the New England ports were above normal in quantity, due to unusually large mackerel and haddock landings. Although the average prices declined slightly, the total value of products was substantially greater than in 1924. Seattle landings were below those of 1924 in quantity and value. The canning industry produced greater quantities of nearly all varieties of canned fishery products, the total value being considerably higher than in recent years. By-products also were produced in larger quantites and were of greater value. Exports of edible fishery products showed an upward trend, while imports for consumption were slightly lower.

Through its division of fishery industries the bureau has been of direct service to the fishery industries by its collection and publication of fishery statisics, its technical research, and its dissemination of practical information to the industry.

Statistics on landings of fish at the ports of Boston and Gloucester, Mass., Portland, Me., and Seattle, Wash., were collected and published monthly. Statistics of the cold-storage holdings of fish were collected by the Bureau of Agricultural Economics in the Department of Agriculture and were published monthly by the Bureau

of Fisheries as in previous years. A noteworthy improvement in the dissemination of this information has been the issuing of a preliminary mimeographed statement, which makes these statistics available to the trade within 15 days of their collection. The trade's appreciation of this service has been particularly evident and gratifying. Statistics of canned fishery products and by-products for the year 1925 were collected and published early in 1926, and those on the production, holdings, and consumption of animal and vegetable oils in the fishery industries were collected quarterly and furnished to the Bureau of the Census for publication as in previous years. The annual canvasses of the shad fisheries of the Potomac and Hudson Rivers were made as usual.

The New England States were canvassed for statistics on the personnel, investment, and yield in the fisheries and fishery industries for the year 1924, and with their publication statistics of this nature are available on the various geographical sections, as follows: New England States, 1924; New York, New Jersey, and Delaware, 1921; Maryland and Virginia, 1920; South Atlantic and Gulf States, 1923; Pacific Coast States, persons and investment for 1922 and products for 1923; Great Lakes and Mississippi River and tributaries, 1922.

These are the only complete statistics available, and it is becoming more and more apparent that intermittent statistics are not capable of yielding the information needed in dealing with problems of conservation. Annual statistics are vital to the determination of the abundance of fishes and would provide the best insurance against depletion and at the same time against ill-advised legislation hastily provided to meet apparent but not real depletion.

The bureau is seeking to obtain such statistics by encouraging their collection by the States, and there seems to be some promise of progress in this respect. The Pacific Coast States have systems for the collection of statistics of such character that it has been possible, by supplementing them with some field work, to compile fairly complete statistics for the years 1923 to 1925. Connecticut has begun to collect complete annual statistics, and some of the States on the Great Lakes are collecting partial statistics.

TECHNOLOGICAL INVESTIGATIONS

Conservation, a primary function of the Bureau of Fisheries, applies to fishery products as well as to fishery life. If there is waste in preserving and marketing the fish or in making use of by-products, true conservation is not effected. The bureau is doing what it can, through technological research, to bring about more efficient utilization of fishery products by improving existing and developing new and better equipment, methods, products, and practices within the various branches of the fishing industry and by showing how properly to utilize wastes and by-products. Few realize the importance of well directed, adequately supported technological research. Rapid progress in industry, and this applies particularly to the fisheries industries, largely depends on such work combined with the application of sound business principles. Work was continued throughout the year on three major lines of research—preservation

of nets, canning of sardines, and utilization of by-products. Progress only will be reported upon here, as these investigations were discussed at length in the last report.

CANNING OF SARDINES

Efforts toward bringing about commercial development of the new process of preparing sardines developed by the bureau are meeting with success. Two small plants in Maine and one in Canada erected equipment and used the new process. The product prepared by these plants is receiving much favor. Another season undoubtedly will bring additional developments.

PRESERVATION OF NETS

Large-scale practical tests of copper oleate and copper oleate-copper paint mixtures were conducted in cooperation with fishermen at several points on the Atlantic coast. These tests, which are still under way, are being made to show the real saving that can be obtained from the proper application of copper compounds upon different kinds of gear. To offset the higher cost of the copper-oleate treatment the bureau now is experimenting with other copper compounds in an endeavor materially to lower the cost of treatment.

UTILIZATION OF BY-PRODUCTS

Research was carried on throughout the year upon decreasing losses in protein and oil wasted in press liquors now discarded in manufacturing fish meal and oil. This work must be continued further before a report can be made upon it.

As a sanitary measure the State of Texas plans to require all shrimp canners to utilize their waste products. When informed of this, the bureau, cooperating with the State, studied the situation and advised the kind of process and equipment best suited for this purpose. It was possible also to show that a reasonable profit could be made from such operations. Similar attention was given to the utilization of market waste and in particular the waste from haddock filleting operations. This work is being continued.

TECHNOLOGICAL ADVANCES IN THE INDUSTRIES

In the fresh-fish field there has been a large increase both in the total amount of fish filleted and in the number of concerns throughout the country that have adopted this practice. This improved method of marketing is doing much to popularize fish and increase its consumption. It also tends to eliminate waste by concentrating large enough amounts of offal in one place to make its manufacture into fish meal profitable. The bureau has shown the industry how to utilize this material.

The quality of canned salmon was better, and the improvement in Maine sardines was particularly marked. In California machines for cutting sardines are now coming into use. This will help to lower costs and tend to free the canners from labor difficulties. In California, too, the canners voluntarily asked the State board of

health to include their establishments in the regular inspection being made of canning establishments.

The menhaden industry has taken definite steps toward improving the quality of their fish meal and oil by installing refrigerating machinery for brine-cooling fish aboard ship. Steamers so equipped can be operated to much better advantage because it is seldom necessary to return to port without a reasonable load of fish. Also, it is possible to go to the best fishing grounds instead of being compelled to fish close to the factory.

The fishing industry made definite plans for carrying on a national campaign to increase the consumption of fish. This should bring about valuable changes, as a good part of their efforts is to be expended in improving technological practices.

CRAB FISHERY OF CHESAPEAKE BAY

It will be recalled that in 1924 the crab industry was in distress, due to scarcity of crabs, and at the solicitation of men in the industry the bureau undertook to investigate the matter and recommend remedial measures. As the biology of the blue crab had been studied previously and its important features are now understood, the investigation was primarily of a statistical nature. It was necessary to determine whether the abundance of crabs actually was declining; whether the crab supplies of Maryland and Virginia were independent of each other; and whether there was preventable wastage in the fisheries and related industries. The investigation proceeded until December, 1925, and it was found that, although there were fluctuations in recent years, the general trend in abundance was downward; that the fisheries in Maryland and Virginia are interdependent, requiring the cooperation of the two States in administering them, and that there was considerable wastage in certain phases of the crab industry.

A preliminary report embodying these findings and containing recommendations for the improvement of conditions was distributed in both States, and at its last meeting the Virginia Legislature took favorable action on most of the recommendations, and it is believed that similar action will follow at Maryland's next legislative session.

MACKEREL STATISTICS

One of the greatest difficulties confronting the important mackerel fishery of the Atlantic coast is the extraordinary fluctuation in abundance of this fish. The uncertain nature of this fishery causes heavy losses in the outfitting by fishermen for the mackerel season, and disastrous gluts in the market alternating with periods of severe scarcity can not be avoided without some means of forecasting the future supply. At present nothing definite is known as to the nature of these fluctuations other than the magnitude of the changes in yield, but fisheries science has now progressed to the point where the nature and causes of such fluctuation permit understanding and possible forecasting if suitable statistics of the yield, of the fishing effort involved in producing the yield, and of the character of the yield are available. In order to provide the material for future study of the problem, work was initiated in 1925 to provide for

the collection of statistics that in future years will be of utmost importance in an understanding of this fishery.

The work during the past season necessarily was of a preliminary nature, providing the groundwork for a definite and continuous program to be prosecuted during future years. As the result of this work it has been found that two major series of statistics will be necessary—first, statistics on the fishing effort and yield so collected as to permit of separate compilation of the various fishing localities, and, second, statistics of the sizes of mackerel, based on representative samples of the catch taken continuously throughout the season and in all the more important regions.

INFORMATION SERVICE

One of the fields of usefulness to the industry and to the general public is the dissemination of information concerning the statistics, methods, and technology of the fisheries and fishery industries. During the fiscal year numerous statistical bulletins were distributed to interested parties and 1,650 letters were written in reply to requests for specific information not otherwise obtainable. There have been requests for special early releases of statistics on certain industries, which we have not been able to grant because of the limited personnel available for the statistical work.

CANNED FISHERY PRODUCTS AND BY-PRODUCTS

The fish canning and by-products industries of the United States and Alaska, on the whole, experienced a most satisfactory year during 1925, producing $80,577,138 worth of canned goods and $14,600,198 worth of by-products, a total value of $95,177,336. This is the largest total in recent years and is 93 per cent greater than that of 1921. Both canned products and by-products contributed to this increase which was made possible by substantial gains in the value of canned salmon, sardines, tuna, and oysters and the increased production of the by-products of the sardine industry in California and the herring industry in Alaska. Among the canned products salmon, as usual, was the most important item, constituting 59 per cent of the value; sardines were next with 16 per cent; tuna next with 10 per cent; and oysters, shrimps, clams, and other miscellaneous products made up the remaining 15 per cent.

The salmon pack amounted to 5,018,550 cases, valued at $47,369,507. Of this total 1,558,615 cases, valued at $15,379,976, were produced in the Pacific Coast States, and 4,459,937 cases, valued at $31,989,531, were packed in Alaska. The Alaska pack was somewhat smaller than the pack of the previous year, due mainly to a decreased yield of red and pink salmon. Although the pack in the Pacific Coast States was larger than in 1924, the increase was not sufficient to offset the decreased Alaska pack, leaving the total pack of 1925 smaller than that of 1924 by 235,027 cases, or 3.8 per cent. This decrease in quantity was more than compensated by increased prices, making the total value of the pack greater than in the previous year by $4,967,905, or 11.7 per cent.

The pack of sardines in Maine (including one plant in Massachusetts), on the basis of one hundred ¼-pound cans to the case, amounted to 1,870,786 cases, valued at $6,716,701, a decrease of 1.5 per cent in quantity and 6.6 per cent in value as compared with 1924. In California the production totaled 1,714,913 cases (forty-eight 1-pound cans to the case), valued at $6,380,617, an increase of 25.4 per cent in quantity and 17.2 per cent in value as compared with 1924.

The production of canned tuna and tuna-like fishes in California, on the basis of forty-eight ½-pound cans to the case, amounted to 1,102,471 cases, valued at $8,499,080. This is an increase of 69 per cent in quantity and 48 per cent in value as compared with 1924.

Canned shrimp, totaling 735,714 cases (48 No. 1 cans to the case), valued at $3,782,819, shows an increase in production of 2 per cent and a decrease of 18 per cent in value as compared with 1924. The total output of oysters was 654,755 cases (forty-eight 5-ounce cans to the case), valued at $3,721,159, an increase of 46 per cent in quantity and 50 per cent in value. The production of canned clam products totaled 331,586 cases (forty-eight 10-ounce cans to the case), valued at $1,850,378. The output of other canned fish, shellfish, fish roe, caviar, etc., was valued at $2,256,877.

The total value of by-products, including those of the menhaden and whaling industries, amounted to $14,600,198, made up of the following items: Fish and whale oils, 13,287,076 gallons, valued at $6,500,191; fish scrap and meal to the value of $4,650,635; shell by-products, 295,149 tons, valued at $2,382,731; fish glue, 510,816 gallons, valued at $589,064; and miscellaneous by-products to the value of $477,577. This is an increase of 51 per cent in the value of oil production, 60 per cent in fish scrap and meal, 1 per cent in shell by-products, and 7 per cent in the value of glue production as compared with 1924.

The menhaden industry recovered to some extent from the slump experienced in 1924, although the 1925 production was still below normal. The items were dried scrap and meal, 30,167 tons, valued at $1,519,458; acidulated scrap, 41,463 tons, valued at $1,102,051; and oil, 6,023,108 gallons, valued at $3,001,106; making a total of $5,622,615 worth of products.

FROZEN-FISH TRADE

As in previous years, statistics of the cold-storage holdings of frozen fish and the quantities frozen in the United States and Alaska were collected by the Bureau of Agricultural Economics, Department of Agriculture, and published by the Bureau of Fisheries in the form of a monthly statistical bulletin. The reports for 1925 show that the average holdings were 44,084,251 pounds, a decrease of 2.1 per cent when compared with 1924, but above the 5-year average by 6.5 per cent. The quantity of fish frozen during 1925 was 91,165,068 pounds, as compared with 97,324,144 pounds in 1924, a decrease of 6.3 per cent. The principal species frozen were salmon (including steelhead), 12,153,615 pounds; halibut, 12,041,155 pounds; whiting, 10,152,799 pounds; mackerel, 8,948,297 pounds; ciscoes (including tullibees), 5,581,273 pounds; sea herring, 5,264,269 pounds; pike perches and pike or pickerel, 5,233,655 pounds.

NEW ENGLAND VESSEL FISHERIES

Statistics of the New England vessel fisheries at Boston and Gloucester, Mass., and Portland, Me., collected by the bureau's local agents, have been published monthly. Two annual bulletins were issued—one showing the catch by fishing grounds and the other by months. The total landings by vessels at these ports in 1925 amounted to 216,869,265 pounds of fish, having a value to the fishermen of $8,115,570. This was an increase over 1924 of 18.5 per cent in the quantity and 16 per cent in the value of products. Of the total 149,038,498 pounds, valued at $6,104,278, were landed at Boston; 49,471,943 pounds, valued at $1,390,580, at Gloucester; and 18,358,824 pounds, valued at $620,712, at Portland, an increase of 13.8 per cent in quantity and 13 per cent in value at Boston, 38 per cent in quantity and 33.5 per cent in value at Gloucester, and 13.8 per cent in quantity and 12.9 per cent in value at Portland. These fish were taken chiefly from fishing grounds off the coast of the United States, about 84.4 per cent coming from these waters, 14.2 per cent from grounds off the Canadian Provinces, and 1.4 per cent off the coast of Newfoundland.

The principal species, in the order of their value, were haddock, 91,886,260 pounds, valued at $2,747,741; cod, 67,250,130 pounds, valued at $2,321,238; mackerel, 26,209,860 pounds, valued at $1,191,152; halibut, 3,561,102 pounds, valued at $655,172; swordfish, 1,527,180 pounds, valued at $385,929; and flounders, 6,637,972 pounds, valued at $275,787. Compared with the previous year, there was considerable increase in both quantity and value of cod, haddock, and cusk and a very large increase in the quantity and value of the catch of mackerel. There was a decrease in the catch of hake, halibut, herring, and swordfish.

The total catch of mackerel by the American fishing fleet in 1925 was 203,961 barrels fresh and 12,442 barrels salted, an increase of 101,894 and 1,601 barrels, respectively, and the largest catch since 1885.

FISHERIES AT SEATTLE, WASH.

Statistics of the fish landed at Seattle, Wash., which were collected by the local agent, were published as monthly and annual statistical bulletins giving the quantity and value of fishery products landed at that port by fishing and collecting vessels during the year. In 1925 this fleet landed 30,394,460 pounds, valued at $2,955,817.

The catch by fishing vessels, and which consisted largely of halibut, amounted to 12,996,550 pounds, valued at $1,594,298. Compared with the previous year this is an increase of 29.1 per cent in quantity and 19.9 per cent in the value of the products landed. The fish landed by collecting vessels amounted to 17,397,910 pounds, valued at $1,361,519, a decrease of 4.2 per cent in quantity and 2 per cent in value.

SHAD AND ALEWIFE FISHERIES OF THE POTOMAC RIVER

The regular annual statistics of the shad and alewife fisheries of the Potomac River were taken for the season of 1925. They show a yield of 204,582 shad, weighing 696,632 pounds, valued at $163,398.

While this was an increase over 1924 of 19 per cent in number, 21 per cent in number of pounds, and 85 per cent in value, it was one of the smallest catches of which there is statistical record. The catch of alewives, amounting to 7,835,380 fish, weighing 3,134,152 pounds and valued at $37,341, was less than the 1924 catch by 42 per cent in number and 34 per cent in value and was one of the smallest catches since 1915.

FLORIDA SPONGE FISHERY

In 1925 the quantity of sponges sold at the sponge exchange, Tarpon Springs, Fla., was 434,672 pounds, valued at $715,097, of which 242,020 pounds, valued at $609,393, were large wool; 29,968 pounds, valued at $44,952, were small wool; 120,748 pounds, valued at $48,300, yellow; 28,622 pounds, valued at $8,014, grass; and 13,314 pounds, valued at $4,438, wire. Compared with the 1924 production this is an increase of 2 per cent in quantity and less than 1 per cent in value.

FISHERIES OF THE GULF STATES

Compilation of the statistics of the fisheries of the Gulf States in 1923 was completed during the fiscal year and published in summary form as Statistical Bulletin No. 670. The results show that the fisheries in these States gave employment to 17,793 persons, of whom 11,132 were engaged in fishing operations, 1,785 in the wholesale trade, and 4,876 in the fish-canning and by-products industries. The investment amounted to $10,535,905, of which $5,196,541 was invested in vessels, boats, gear, and shore property used by fishermen, $1,975,223 in the wholesale fish trade, and $3,364,141 in the canning and by-products industries. The yield of the fisheries aggregated 160,324,042 pounds, valued at $8,096,650. The output of the canning and by-products industries was valued at $6,264,913.

Shrimp, with a production of 44,246,177 pounds, valued at $1,735,422, was the most important fishery product of the Gulf States, constituting 21.4 per cent of the total value of fishery products. Other important products were oysters, 25,453,309 pounds or 3,636,187 bushels, valued at $1,587,945; mullet, 30,797,824 pounds, valued at $1,207,114; sponges, 574,593 pounds, valued at $873,572; red snapper, 11,728,845 pounds, valued at $864,857; and squeteagues or "sea trout," 4,356,906 pounds, valued at $426,668.

Compared with 1918, the last available statistical report, there was an increase of 19.5 per cent in the number of persons engaged, 61.2 per cent in the amount of capital invested, 22.5 per cent in the quantity, and 24.4 per cent in the value of fishery products landed by the fishermen. A large portion of this increase was due to the growth of the shrimp-canning industry and is the outstanding feature of recent developments in the Gulf fisheries.

FISHERIES OF NEW ENGLAND

During the past fiscal year the fisheries of the New England States were canvassed for statistics pertaining to 1924. Results were published in condensed form in Statistical Bulletin No. 703. Ac-

cording to these statistics the New England States employed 24,513 persons in their fisheries and related industries, of whom 15,983 were fishermen, 1,922 were employed in the wholesale fish trade, and 6,608 in the canning, salting, smoking, and by-products industries. The investment amounted to $28,561,824, of which amount $14,984,327 were invested in vessels, boats, and apparatus used in fishing, $6,089,306 in the wholesale fish trade, and $7,488,191 in the canning, salting, smoking, and by-products industries. The yield of the fisheries aggregated 406,822,165 pounds, valued at $18,818,132. The output of the canning, salting, smoking, and by-products industries was valued at $14,253,831.

The most important product of the New England fisheries in 1924 was the cod, the catch of which amounted to 89,218,355 pounds, valued at $3,075,965, or 16.35 per cent of the total value of the fishery products of these States. Lobsters ranked next, with a catch amounting to 9,716,196 pounds, valued at $3,072,411. Other important species were haddock, 93,518,826 pounds, valued at $2,656,900; oysters, 11,301,829 pounds, valued at $2,070,006; mackerel, 26,653,363 pounds, valued at $1,519,438; flounders, 30,854,736 pounds, valued at $1,339,076; clams, 7,961,000 pounds, valued at $1,065,531; halibut, 4,500,931 pounds, valued at $788,925; herring, 60,235,656 pounds, valued at $661,679; and swordfish, 2,882,214 pounds, valued at $527,726.

Compared with 1919, the last previous year for which statistics of this section were collected, there was a decrease of 20.3 per cent in the number of persons engaged, 29.6 per cent in the amount of capital invested, and 12.9 per cent in the quantity, and 5.1 per cent in the value of the products landed by the fishermen. The outstanding developments shown in the yield are the greatly increased haddock and flounder landings and the continued decrease in the catches of halibut, shad, and lobsters.

BIOLOGICAL INVESTIGATIONS

PROGRESS IN FISHERY RESEARCH

A review of the progress made in fishery investigations during recent years indicates that a distinct branch of scientific study that may be termed " fishery science " has been developed. It is a branch of aquatic biology and zoology, includes ichthyology and geographical distribution, is based upon oceanography and marine ecology, and employs the methods of the biometrician and the student of vital statistics as well. The emergence of this branch of science is the result not only of the maturing and perfecting of scientific methods with the resulting opportunities for practical application of knowledge thus obtained but also of the growing recognition of the need for conservation of natural resources. With increased facilities and opportunities for recreation comes a decrease in food and game fishes; with the increased facilities for commercial exploitation and a wider utilization of sea foods comes a shortage of the sea fishes. More efficient exploitation, the result of the economic development of the fishing industry with its tendency toward concentration in larger units and its employment of higher managerial and technical skill,

has focused the attention of increasing numbers of people upon the problem of developing and maintaining a permanent supply of fish. This is the immediate problem, with its many ramifications, upon which the scientific investigations of the bureau are focused.

Fishery science differs from the older marine biology not so much in method or even in subject matter as it does in point of view. Its object is the discovery of the limiting factors that regulate the abundance of the various species of fish of commercial value and the application of this knowledge to the protection and wise utilization of these species. In this sense it is an applied science and may be likened to the science of animal husbandry. Indeed, the husbandry of fishes on a thoroughly practical and scientific basis is a goal toward which we may strive with hopes of not too distant attainment. But fishery science is so unorganized that the causes that control the fluctuating abundance of fish are little understood and require the study of a great range of fundamental and often elementary facts in aquatic biology. Because of this great diversity of subject matter the principle of cooperative research that has been found so effective in other lines has been applied to the major projects of the division's work. As an example of cooperative or group research in fishery science the investigation of the cod fishery in the western North Atlantic may be cited. This investigation is not only being carried on by the three governments most directly concerned in the prosperity of this fishery, but each investigator is attacking the problem from a different angle.

The present state of the cod fishery and the distribution of fish (in point of abundance) on the fishing banks and inshore areas is being determined by a statistical analysis of the records of yield. The factors that affect this varying abundance are being sought by studying the embryology and early life history of the fish, its period of spawning and rate of development, the migration from bank to bank, the localization of the distinct races of the species, and such physical factors as temperature, salinity, currents, etc., that affect the fish throughout its entire life. A knowledge of its food habits also is being attained, together with the variations in character and abundance of the microscopic organisms upon which it depends for its food in the early stages of its growth. Thus statisticians, biologists, biochemists, planktonologists, and oceanographers are cooperating to a degree scarcely attained heretofore, each conducting investigations that individually may be considered problems in pure science but which are so coordinated and centralized that complete and useful understanding of the fishery and its problems is rapidly being attained.

The investigations of the fisheries of the North Atlantic are being fostered, and to a large degree directed, by the North American Committee on Fishery Investigations, composed of delegates from the countries having the largest fishing interests in this region, namely, Canada, Newfoundland, the United States, and France. A meeting was held in Montreal in November, 1925, at which Dr. H. B. Bigelow and O. E. Sette represented the United States. In order to evaluate the total productivity of the North Atlantic fishing banks, plans were made to secure mutual exchange of fishery statistics between all of the countries participating, and in the furtherance of

this plan an invitation of membership was extended to Portugal, for it is known that Portuguese vessels engage extensively in the Newfoundland banks fisheries. Plans were drawn for improving the statistics of the fisheries in order to make available information on the fishing effort, and hence arrive at some measure of the real abundance of the fish. Plans for extending and perfecting cod, haddock, and mackerel investigations and studies of ocean currents were made.

ADVISORY COMMITTEE ON SCIENTIFIC INVESTIGATIONS

In order more clearly to define the program of investigations of the bureau and to provide for a continuity of policy and more complete coordination of the various branches of the service, an advisory committee on scientific investigations was appointed by the Secretary of Commerce in March, 1926. This committee, uniting such interests as those of eminent scientists, fishery administrators, commercial fishermen, and bureau officials, consists of the following members: Dr. H. B. Bigelow, consulting oceanographer, Harvard University; N. B. Scofield, California Fish and Game Commission; Capt. F. W. Wallace, editor, Fishing Gazette; Dr. W. H. Rich, chief Pacific salmon investigator; and Elmer Higgins, chief of the division of scientific inquiry. At a preliminary meeting held in May the policy of the division of inquiry was considered, and it was decided that in order to increase the effectiveness of the biological stations of the bureau, in the event of overcrowding, volunteer investigators be selected in the future from among those who have shown ability in conducting energetic and productive research and who are engaged in the investigation of problems closely related to the fisheries. The principle of stressing the investigation of the immediate rather than the ultimate problems of the fisheries was formally approved, and other details of the work were considered.

The demands upon the bureau for investigations are so numerous, the interests so diverse, and the areas to be covered so great, that in many lines effective research is seriously handicapped. Through cooperative arrangements with several State fish commissions, however, much more has been accomplished than would have been possible otherwise. Joint investigations by the bureau and the State governments previously initiated include work on the oysters in Georgia, the mullet and sea-trout fisheries in North Carolina, salmon investigations in California, Oregon, and Washington, and a study of food supply in lake waters in Michigan and Wisconsin. Additional projects have been undertaken in South Carolina and Texas, where oyster resources are being investigated. The coastal fisheries of Texas are receiving particular attention. Following is a brief résumé of results of the more important activities of the division of inquiry.

ATLANTIC COAST FISHERIES

The cod, pollock, and haddock fisheries of the north Atlantic are some of the most remarkable fisheries in the world. Situated in an exceptionally rich and extensive area of shallow waters, comprising the Gulf of Maine and the offshore banks, this fishery has supplied, with apparently undiminished productivity, over 140,000,-

000 pounds of fish annually for many years to American ports alone. The total productivity of the area never has been determined, due to the fact that the fishery is exploited by the ships of several nations from whom statistics of the yield are not available. However, with the development of improved methods of preparation and marketing, there is little doubt but that these fisheries are entering upon an era of unprecedented exploitation that will test to the utmost the capacity of the stock to supply the demand. Therefore it behooves American industry to safeguard itself against overexploitation, ultimate depletion of the fishery, and economic disaster, by careful and continuous observations on the condition of this resource. Accordingly, intensive investigations of the fish stock and of the food supply upon which it depends have been pursued energetically by the bureau for several years.

Investigations of the fisheries for cod, pollock, and haddock, of the spawning habits and early development of the fish, of the plankton organisms, and of the physical factors of environment have been conducted during the past year. The study of the stock of adult cod, of its age and rate of growth, its segregation or migrations from bank to bank, and the various shore areas has received particular attention. During the past three years 36,792 cod, pollock, and haddock were tagged and liberated, and 1,672 of these, or 4½ per cent, have been recaptured. During the past fiscal year 7,943 of these fish were tagged and liberated. By careful analysis of the tagging records much has been learned of the migrations and habits of these fish. The outstanding results of these experiments are as follows: Cod tagged on Nantucket Shoals migrate each fall to the shore waters of Rhode Island, Long Island, and New Jersey. The majority are retaken on Nantucket Shoals where they were tagged, only a few being found in South Channel, on Georges Bank, or north of Cape Cod. Cod tagged in Massachusetts Bay or on Stellwagon Bank apparently scatter both north and south, but fish tagged on Platts Bank and the southern coast of Maine are quite localized, showing little migration at all. Farther north, however, cod tagged at Mount Desert frequently were recaptured to the north in the Bay of Fundy, although fishing was so intensive that over 20 per cent of all the tagged fish liberated were recaptured locally and returned. A collection of over 10,000 scales from cod and other fishes made during the tagging experiment of 1924 and 1925 is being studied to determine ages and rates of growth in the various areas to supplement the knowledge of the stock of fish.

In connection with these studies detailed investigations of the occurrence of eggs and larvæ are being conducted. These are of importance in an understanding of possible depletion and variation in abundance, for it has been found that the cod found spawning in the western inshore waters of Massachusetts Bay produce eggs that do not remain in that area to renew the population but are carried out of the bay and develop in other regions. The same is true in Ipswich Bay, although it has not yet been discovered if these eggs are carried into Massachusetts Bay or out to sea, thus stocking offshore banks.

During the past year a notable contribution to our knowledge of the fisheries has been made in a report on the "Plankton of the offshore waters of the Gulf of Maine." A report on the physical

oceanography of the same region marks the culmination of several years of investigation and provides data more complete than those for any similar area of American waters. This very important study of oceanography, or the physical environment of fish in the sea, is being extended to the offshore regions of the various banks. To aid in conducting the work, a suitable vessel has been acquired from the Navy Department. Further study of the general ocean drift and local currents by means of drift bottles, and direct observations on temperatures, salinities, and other physical characteristics of the ocean circulation, together with the contained microscopic life, will be continued and correlated with the fluctuating yield of the fisheries.

The mackerel investigations initiated last year have been continued. Progress has been made in determining the ages of the fish composing the various runs, and the study of migrations, by means of tagging experiments, has been extended. An attempt is being made to foretell seasons of great abundance or scarcity of mackerel by studying their habits and the relative numbers of fish of various age classes that make up the catch. The results of these biological investigations are being correlated with the statistics of the fishery, and on this account the formulation of conclusions must be delayed pending the accumulation of several years' data.

Observations on the fish and fisheries of Chesapeake Bay have been made by the bureau from time to time for many years. Our knowledge of this region has been materially increased by a recent intensive survey, the assembling of all previous records, and the compilation of an extensive report, which not only gives descriptions and an authoritative account of the systematic relationships of all the fishes known to occur in the bay, but includes a great amount of information on the natural history of the more important species. An analysis of the statistics of the fisheries covering a long period, together with a detailed study of the seasonal abundance of a great many species and considerations of economic bearing, makes the report of particular value.

In the South Atlantic States the staple food fish is the mullet, which yields approximately 40,000,000 pounds of products annually. The fishery is conducted in shallow sounds and inshore water areas from North Carolina to Texas, but is most highly developed in Florida and North Carolina. The fishery has been declining in productivity for a number of years in several localities because of wasteful and destructive fishing and for other reasons, and an investigation begun during the last fiscal year was continued. The preliminary work has shown that the mullet of North Carolina and Florida belong to distinct races. It is shown further that various other racial units exist, so that the problems of conservation are of a local nature and remedial measures must be devised to fit the needs of each separate locality. Depletion in this fishery apparently has occurred more rapidly in North Carolina than elsewhere, and particular attention is being given to the fishery in that region.

Many fish were tagged and liberated and their migration routes traced. In this way it was shown that the stock native to the North Carolina coast, while taking part in a regular annual migration from the sounds to the sea, does not migrate to South Carolina or waters

farther south to any appreciable degree, as was popularly supposed. A study of the commercial runs indicates that this species is greatly influenced by weather conditions, which not only affect their migrations but in all probability the abundance of the fish. Fluctuation in abundance from year to year is a characteristic of the species, and it is not improbable that the present studies, if carried on annually, will make possible reliable predictions as to the abundance of runs in future years. Knowledge of the spawning habits and early development of the species will aid in the formulation of effective regulation of the fishery.

One of the most serious problems, and in all probability one of the most fruitful causes of depletion, is the destruction of immature fish that are unmarketable, and hence economically worthless, but which possess high potential value. Certain types of fishing gear are known to be extremely destructive of these small fish, and millions are destroyed annually in the inshore fishery. The seriousness of the situation was recognized in North Carolina, where extensive seine and pound-net fisheries are conducted in the shallow waters of the sounds. At the request of the State fisheries commission, and with its cooperation, an investigation of the destruction caused by various types of gear was undertaken. Careful analysis of the catches of both pound nets and seines throughout the fishing season showed that a most amazing waste of immature gray trout or squeteague occurred in the pound-net fishery, while haul seines were remarkably free from blame in this respect. In some parts of Pamlico Sound in June as many as 78 per cent of the gray trout taken were below the legal minimum size limit of 9 inches, while the average amount wasted in the entire pound-net fishing area was 54 per cent by number. Other valuable fish also were destroyed in surprisingly large proportions. This waste decreased during the early summer and reached the more reasonable figure of but 10 per cent in August. From a consideration of facts in the life history of the fish, brought out in the course of the investigation, and from economic considerations as well, it was concluded that this destructive practice should be abated by the imposition of a closed season during May, June, and July. As such a period coincides with the spawning season of the squeteague, and as the tremendous waste of young individuals would thus be eliminated, it is confidently believed that the resident stock of these fish, or those that annually visit the sounds, would be materially increased in a few years to the economic benefit of all concerned. Specific recommendations to this effect were made to the State authorities.

The most important fishes of the coast of Texas are the spotted trout or squeteague, the redfish, and the black drum, all of which are esteemed by the sportsmen and the commercial fishermen. It is popularly supposed that these species are declining in abundance to an alarming extent, and the bureau was called upon to make an investigation and suggest remedial measures. A preliminary survey was undertaken and a report that affords a foundation for a more thorough investigation was prepared. All available records of the past and present status of the fisheries were studied, the known habits of the commercial species were reviewed, and a plan of biological research was outlined. A revision of the present method of administering the fisheries and the application of a rational policy of con-

servation were recommended. A thorough study of the biology of the important commercial species is now being conducted with the active cooperation of the State, and plans for regulating the fishery are being developed.

OYSTER INVESTIGATIONS

The oyster industry of the Atlantic coast yields $14,000,000 worth of products annually. In many ways this is the most important fishery on the Atlantic coast. It is prosecuted in every coastal State from Massachusetts to Texas, but in many localities it has declined to an alarming extent, the total decrease in yield in the last 20 years amounting to almost 60 per cent. While this decline may be due mainly to overfishing, the progress of civilization and the industrialization of rivers and harbors, with the attendant pollution, may be looked upon as important, if not the most important, causes of the decline. However, the oyster is so well adapted to cultivation that relief from the present scarcity may be sought through perfected methods of farming and regulated exploitation.

Despite the fact that the oyster has been cultivated for hundreds of years and is one of the best-known mollusks, there is a surprising lack of exact information concerning its life history. These problems are being attacked in a systematic manner at the bureau's Woods Hole laboratory, where careful experiments on the physiology of feeding, growth, and reproduction are being conducted. By means of specially constructed apparatus it was possible to measure accurately the rate of flow and the volume of water passed through the gills of the oyster. This was found to vary with the temperature of the surrounding water, reaching a maximum at 77° F. and ceasing at 45° F., when the condition of hibernation is said to exist. The feeding of the oyster was studied, and it was found that over 99 per cent of the microscopic organisms carried in by the current of water were consumed. Experiments on the problems of sanitary control of oyster beds also were conducted, and it was found that but very few of the bacteria in the water are retained as food by the oyster. Lately, studies on the physiology of spawning have been undertaken, with the view of determining the concentration of adult oysters necessary to produce an abundant set of spat.

In addition to the laboratory studies, controlled field experiments in the Long Island Sound region at Milford, Conn., have been carried on. Studies in spat collection resulted in the development of a particularly successful type of collector, which it is believed will increase the total yield of seed oysters that can be produced upon a given area. The factors affecting the set of spat, such as current, depth, and character of surface, as well as the habits of the larvæ were studied carefully. The discovery of an entirely unknown habit of the young larvæ to settle upon and burrow in the bottom enables us better to understand the relation between spawning beds and setting areas and the effect of tides, waves, and currents upon distribution. Extensive studies made in previous years resulted in the perfection of methods of hatching and rearing oysters in tanks and troughs. While this method of propagation is entirely feasible, more recent studies have indicated that the greatest return in the Long Island

Sound region is had by transplanting quantities of seed oysters grown under favorable or controlled conditions.

A survey of the oyster beds on the Texas coast was made from December to March. Biological and hydrographical observations were carried on from Galveston to Corpus Christi in the many bays and sounds that indent the coast. These localities presented such a variety of conditions that it was necessary to formulate detailed recommendations for the various situations. Oysters occur either on the reefs, where they grow in great abundance, covering every available space, or scattered on the bottom, where the mud is stiff enough to support the weight of the shells. Due to the overcrowded conditions, the reef oysters are of very poor quality, while those scattered over large areas frequently are of very high quality but in many places are seriously depleted from overfishing. The salinity of these waters is subject to considerable fluctuation throughout the year, but with the cooperation of the State authorities the series of observations initiated during the survey is being continued for an entire year in order to determine the extreme variations under which oyster culture can be conducted successfully. Preliminary recommendations for planting in suitable waters already have been prepared, and additional recommendations will be submitted after a year's complete records have been analyzed.

Further experiments in transplanting seed oysters and collecting spat, which were initiated in Georgia last year, were successful. Unfortunately in this State experimental work in oyster culture is hampered by lack of funds, but it is believed that oyster farming can be developed as a profitable enterprise in Georgia. Brief surveys of the oyster beds on the coasts of Louisiana and South Carolina were completed during the year, and plans were made for more thorough work.

PACIFIC COAST FISHERIES

One of the greatest tasks confronting the bureau, but which at the same time is one of the greatest opportunities for public service, is the conservation of the salmon fisheries of the Pacific coast. These fisheries, which annually produce manufactured products valued at from $40,000,000 to $50,000,000, have declined seriously in many localities due to long-continued overfishing. The entire administration of the fisheries of Alaska is vested in the Department of Commerce, acting through the Bureau of Fisheries, and the responsibility of conserving them is fully recognized; but the protection of the salmon fisheries is dependent upon extensive biological investigations of the life and habits of the fish, particularly is it necessary to determine which streams contain the more important spawning beds and the relation between these and the fishing centers.

In cooperation with the International Pacific Salmon Investigation Federation, the bureau established a laboratory at Seattle, Wash., and Dr. Willis H. Rich, the former chief of the division of scientific inquiry, has been placed in charge of an extended program of study. Much practical information has been obtained from tagging experiments conducted during the last four years. A report on the earliest of these was published in 1925, and one covering the results of the tagging experiments of 1924 and 1925 at Port Moller, Alaska, and in southeastern Alaska is in press.

Experiments initiated several years ago to determine the relation between the numbers of spawning fish and the numbers of their progeny that returned at maturity are nearing completion. Weirs have been operated for the last four or five years at Chignik and Karluk, Alaska, and at other places where the extent of the escapement of salmon into the spawning streams has been determined by actual count. Detailed observations of the young resulting from the first complete life cycle of fish at Karluk were under way during the spring of 1926, and 48,000 of the returning young salmon were tagged and liberated. Knowledge thus obtained makes it possible to determine what regulations are necessary to insure an adequate escapement of spawning fish to maintain and build up future commercial runs, and it is confidently expected that the stock of salmon can be so regulated that eventually salmon streams may be restored to their original productivity.

The investigations of the salmon of the Columbia River, conducted in cooperation with the Oregon Fish Commission, have yielded valuable results, not only in affording an understanding of the habits of these salmon but in proving the importance of certain changes in fish-cultural methods, such as the use of rearing ponds to hold the salmon fry until the proper time for liberation. Salmon-marking experiments have been conducted for a number of years. Returns of marked yearling sockeye salmon liberated in February, 1924, have been exceptionally numerous; but from a previous experiment, in which the young fish were liberated in the fall of their first year, no returns were received. These results agree with those of former experiments in showing that when it is not possible to liberate sockeyes in a lake in which they can remain until the spring of their second year (which is their natural time of migration) they should be held in rearing ponds until that time. Many other marking experiments with chinook salmon in the Columbia River have been followed energetically with excellent results. In addition to these studies, the life history of the blueback salmon in the Columbia River has received attention and a complete report is in preparation.

A biological investigation of the herring of Alaska begun in the spring of 1925 was continued in 1926. A preliminary survey was made of the commercial fishing establishments throughout the region, and research into the composition of the fish stock, natural fluctuations in abundance, and overfishing was initiated. As a necessary preliminary to other work, a study was begun to determine whether local races exist and the degree of variation between them. From measurements of physical proportions and counts significant differences have been discovered, which indicate that the races of herring in southeastern Alaska are different from those to the westward, and these again are distinct from the races that occur farther south in the States. The herring fishery of the Northwest is capable of great expansion, and it is hoped that these biological investigations will develop means for preventing depletion.

FISHERIES OF INTERIOR WATERS

During the past year a comprehensive report on the commercial fisheries of the Great Lakes was published, a report on detailed studies on the life history of the lake herring in Lake Huron has

been submitted, and an equally comprehensive study of the systematic relationships and natural history of the whitefishes of the Great Lakes has been brought to virtual completion. While the total yield of the commercial fisheries of the Great Lakes region has not declined appreciably in recent years, there has been a noticeable reduction in the take of such valuable species as the whitefishes and ciscoes, their place having been taken by less desirable species. The discovery that whitefishes are divided into numerous species not previously recognized, many of which are extremely localized in their distribution, explains the possibility of depletion of these more valuable forms. While overfishing is recognized as the chief probable cause of the decline, pollution of the fishing grounds and spawning areas is considered an important factor. An understanding of the natural history of many of these species now makes possible the formulation of effective regulations for the protection of the fisheries and the agreement upon a policy of protection by the several States and the Canadian Government.

In response to public interest in the development of the fisheries of the interior waters, the bureau is giving attention to the problems of aquiculture or water farming, such as the improvement of practical fish-cultural practices in Federal and State hatcheries and fundamental studies in the physiology and nutrition of fishes, the prevention or treatment of diseases, and the development of a superior brood stock. Experiments in feeding rainbow and brook trout with the customary foods to which have been added other substances that contain the various vitamins have been conducted, and while the entire significance of apparently conflicting results is not fully understood many facts have been adduced. These experiments indicate that each species of trout reacts differently to different feeding rations, that certain commercial foods are of little value, and that the practice in many hatcheries of feeding stale foods is distinctly detrimental. This work has been conducted on an extended scale at the Holden (Vt.) experiment station, and an analysis of the results is under way. Studies on the treatment and control of fish diseases have been continued, and advice has been given freely by the bureau's pathologist to numerous trout and goldfish producers and to various State and private hatcheries.

Extensive experiments in pond culture have been undertaken at the Fairport (Iowa) biological station with a view to increasing the productiveness of ponds and of more fully utilizing marshy lowlands as sources of food supply and recreation. The entire pond system of the station is being employed in studies on increasing the food supply of the fish by means of fertilizers and the production of an abundant supply of forage fishes for bass and other carnivorous species. The raising of buffalo fish and bass is being undertaken under semicontrolled conditions, and detailed observations on environmental factors affecting their growth are conducted regularly.

Closely correlated with the work in aquiculture are the studies in limnology that are being conducted in cooperation with the University of Wisconsin. Highly significant studies on the basic food supply in fresh-water lakes have been made as part of this program, and a report that adds materially to our knowledge of the subject has been submitted for publication.

INVESTIGATION OF SHELLFISH AND TERRAPIN

Shellfish investigations, aside from those on the oyster, include studies of the Pacific coast clams, the scallops of North Carolina, and the fresh-water mussels of the Mississippi River Basin. As a result of the investigation of the life history and ecology of the razor clam in Alaska, regulations have been framed that will tend to overcome depletion from overfishing and restore the productiveness of the natural beds. The report on these investigations, published in 1925, points out that the growth rate of the razor clam in Alaska is approximately half that of clams of the Washington coast, and on this account commercial extinction of the species here is much more probable than on the southern beds. These studies were continued during the past year and further information on the growth and abundance of clams on the various beds in Oregon and Washington have been made, the results of which are being summarized for publication.

The scallops of North Carolina, although extremely localized, occupy an important place in the fisheries of that State. The existence of the species was threatened in 1924 by an unusual flood of fresh water late in that year, which resulted in the virtual failure of the fishery the following season. At the request of the State authorities the bureau began an investigation of the biology of this mollusk, which resulted in specific recommendations being made for the regulation of the fishery to permit the maximum take of scallops without endangering the supply. It is reported that this season the species returned to approximately its former abundance.

Document No. 865—The Fresh-Water Mussel and Mussel Industries of the United States—which has proved so popular is being revised. It appears that the mussel fishery of the Mississippi River Basin is one of the largest of our fresh-water fisheries. The yield during 1922 was approximately 52,000,000 pounds of shells, with a value of over $1,000,000, while the manufactured products, which consist of pearl buttons and novelties, were valued at nearly $8,000,000. Investigations of the mussel resources and of the biology of the various commercially important species have played an important part in the development of this industry, and the brilliant researches of the early workers have been considered one of the notable achievements of the bureau. With the depletion of the more accessible beds, attention was turned to the possibilities of artificial propagation, and successful methods were developed at the Fairport laboratory. During the past year further experiments have been conducted in the rearing of mussels in hatchery troughs, but these have been subordinated to the researches in the elimination of the parasitic period in the life of the glochidia. Careful studies on the acid alkali balance in the blood of the fish have been an important link in the effort to rear the larval mussels without host fishes. While the methods have not been completed, prospects are extremely promising and if successful will revolutionize methods of mussel propagation.

Close cooperation with the various States has been maintained in perfecting protective legislation. During the spring months an extensive survey of the mussel-producing areas in the White and Black Rivers in Arkansas was conducted at the request of the State fish

and game commission, and the regulations proposed were enacted into law.

Artificial culture of the diamond-back terrapin, which has been conducted at the Beaufort (N. C.) biological station for a number of years, has definitely passed from the experimental to the practical stage. Although there are yet many problems to be solved in the cultivation of terrapin, methods have been so nearly perfected that a cooperative arrangement with the State of North Carolina has been made, whereby the depleted waters of the State are to be restocked from the breeding pens of the station. The bureau now has on hand 960 adult female terrapins, to which 1,292 have been added during the year by the State to form the brood stock. While a large number of the young produced in 1925 were retained for further experimental purposes, 1,800 young were liberated in the marshes and 600 remain on hand for later distribution. It is expected that about 4,000 young will be produced by the original brood stock during the laying season of 1926, and that by 1927, when the brood stock acquired by the State commission will begin to produce, over 12,000 young terrapin will be reared for distribution. With the five-year closed season on terrapin enacted by the State in 1925, and the increased production of young terrapin by the bureau, it is confidently expected that the terrapin resources of the State will ultimately return to normal.

OUTSTANDING PROBLEMS

We have seen thus far that notable progress has been made in the solution of many urgent problems of the fisheries. It can not be assumed, however, that all of the important problems have received attention. The bureau's resources in men and funds are not sufficient to satisfy the many demands for investigations on problems of real importance. Because of the need for national economy it has been necessary to curtail many investigations, and in many cases the initiation of new work has been deferred, to the detriment of the fisheries and the danger of great economic loss.

It has long been recognized that the shad fisheries of the Atlantic coast are facing slow destruction from overfishing and pollution, yet it is impossible at present to suggest methods of protection. Serious pollution of rivers and harbors is a continuous menace to aquatic life, yet full understanding of the problem and means of relief are still beyond our reach. On the Gulf coast a great shrimp fishery has grown to enormous proportions in the past five years. It is inconceivable that the present rate of development of this fishery can continue without the early depletion of the resource, but little is known of the life and habits of the species or of its ability to withstand the strain of exploitation. Other important fisheries of the Atlantic coast are suffering rapid decline. The sturgeon already is seriously depleted; the bluefish has shown marked decline in abundance; the smelts of the New England coast are greatly reduced in number; lobsters are no longer plentiful; and drastic restriction of the crab fishery is believed to be the only hope of saving it. All of these matters require immediate investigation, for the problems

of protection are difficult to solve and delay may result in serious consequences.

VESSEL SERVICE NOTES

The fishery investigations of the Gulf of Maine were continued by the steamer *Halcyon*, assisted in longshore work by the steamer *Gannet*, the former cruising some 3,500 miles and the latter nearly twice as many. In February the *Halcyon* was sent to the Portsmouth (N. H.) Navy Yard, where her officers and crew rendered efficient service in assisting in the reconditioning of the *Albatross II*. This work occupied the remainder of the fiscal year. The *Gannet* was utilized in fish-cultural work for the Boothbay Harbor (Me.) station during the flatfish season.

The steamers *Phalarope* and *Shearwater* and some 58 motor boats have been used for fish-cultural work at the various stations of the bureau and for biological work at its laboratories.

The 12 vessels of the Alaska service cruised over 74,000 nautical miles during the fiscal year 1926. Of this total the *Eider* made about 17,000 and the *Kittiwake* about 11,000 miles.

The *Eider* was employed chiefly as a tender for the Pribilof Islands, with headquarters at Unalaska, the nearest harbor, 250 miles distant. The vessel also was engaged for a brief period during the summer in connection with the investigation and protection of the salmon fisheries.

In southeastern Alaska the patrol vessels *Widgeon*, *Murre*, and *Auklet* were engaged on fishery protection work throughout the year and the *Petrel* for part of the time. The *Blue Wing* was occupied in patrol work in the Kodiak-Afognak district, the *Merganser* in the Alaska Peninsula region, the *Ibis* at Chignik, the *Scoter* in Bristol Bay, and the *Tern* on the Yukon River.

An important addition to the Alaska patrol fleet was the *Brant*, which was built at North Bend, Oreg., where it was launched on June 3, 1926. This vessel is 100 feet in length, 21 feet in breadth, and is equipped with a 225-horsepower full Diesel engine. It is strictly modern and seaworthy, and on its initial trip to Alaska, sailing from Seattle on July 9, 1926, rendered highly satisfactory service. This vessel is adapted to patrol duty in exposed coastal waters.

The *Sea Gull*, which was purchased in 1924 for patrol work on the Copper River flats, was accidentally destroyed by fire on June 18, 1926. This boat was 31 feet in length, and with one exception was the smallest of the Alaska service fleet.

DISPOSAL OF THE "FISH HAWK" AND ACQUISITION OF THE "ALBATROSS II"

During October and December, 1925, the steamer *Fish Hawk* did her last work for the Bureau of Fisheries when she made two short cruises to Provincetown and Stellwagen Bank for the purpose of tagging mackerel and codfish. In January, 1926, she was taken to the station of the bureau at Woods Hole, Mass., and was there put out of commission on January 30 and the naval crew released. The *Fish Hawk*, as well as the *Albatross*, was manned by officers and men assigned by the Navy.

The *Fish Hawk* was an important factor in the activities of the former United States Fish Commission and the present Bureau of Fisheries for nearly 46 years. She was constantly engaged in fishery investigations from Maine to Texas, among which may be mentioned especially the oyster investigations on the Texas and Florida coasts and the expeditions to Porto Rico in 1898 and 1899. In the war with Spain and in the World War the vessel was taken into the naval service.

The *Fish Hawk* was designed by Charles W. Copeland, consulting engineer of the Lighthouse Board, and was built in 1879 by the Pusey & Jones Co., of Wilmington, Del., where she was launched on December 13 of that year and turned over to the United States Fish Commission on February 23, 1880. The vessel is of 441 gross tonnage, 156 feet 6 inches long over all, and of 27-foot beam. The hull below the main deck is of iron, sheathed with yellow pine. Above the main deck the construction is of wood. She was intended primarily for coastal work and was not designed for offshore cruising. She was equipped with a laboratory, sounding and dredging apparatus, and on her main deck there was originally installed a very complete hatchery. Later, however, the hatchery equipment was removed, as it was no longer desirable to use the vessel for this purpose. In recent years the necessity for extensive repairs on account of the vessel's age became imperative, and owing to the fact that she was becoming obsolete and unfitted for present-day needs it was not felt that the large cost of reconditioning her was justified, and accordingly she was condemned and sold on June 1, 1926.

To take the place of the *Albatross* and *Fish Hawk* there has been obtained from the Navy Department the ocean tug *Patuxent*, the name of which has been changed to *Albatross II*. This steamer is an excellent ocean-going vessel, and it is believed will fill the bureau's requirements for many years as efficiently and more economically than either of her predecessors. She will carry a crew of 26 men and has ample accommodations for investigators besides a sufficiently commodious laboratory. She will be equipped with requisite apparatus for oceanographic and collecting work. She is now being altered extensively to fit her for the bureau's needs, and it is expected she will be ready for active service early in the coming fiscal year.

The *Albatross II* was built at the Norfolk Navy Yard in 1909. She is a two-masted steamer of 521 gross tons, built of steel, except the masts, trimmings on deck houses, boat and bridge deck, and main deck. The latter is of iron with a wood deck laid on top. Her length over all is 156 feet, breadth molded 29 feet 6 inches, and mean draft 12 feet 3 inches. Radio antennæ extend between the two masts, and a cargo boom is attached to the mainmast above the deck houses. The hull, boats, deck houses, and bulwarks are painted white. Masts, funnel, davits, ventilators, and trimming on houses are navy buff.

Two single-end Scotch boilers furnish power for two vertical triple-expansion engines with a combined horsepower of 1,160. She is equipped with steam steering engine, steam windlass, and steam capstan and wireless apparatus. Two generators furnish lights and

current for two searchlights. There are an evaporator and distiller of 1,000 gallons capacity.

APPROPRIATIONS

The regular appropriations for the bureau for the fiscal year 1926 aggregated $1,589,140, as follows:

Salaries:	
Office of the commissioner and field	$625,950
Pay, officers and crews of vessels, Alaska service	47,790
Miscellaneous expenses:	
Administration	3,900
Propagation of food fishes	400,000
Maintenance of vessels	105,000
Inquiry regarding food fishes	43,500
Fishery industries	25,500
Protecting sponge fisheries	2,500
Protecting seal and salmon fisheries of Alaska	310,000
Upper Mississippi River fish rescue	25,000
Total	1,589,140

Respectfully submitted.

HENRY O'MALLEY,
Commissioner of Fisheries.

To Hon. HERBERT HOOVER,
Secretary of Commerce.

PROGRESS IN BIOLOGICAL INQUIRIES, 1925[1]

By WILLIS H. RICH, *Assistant in Charge of Scientific Inquiry*

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INTRODUCTION

The work of the division of scientific inquiry during 1925 gave unusually encouraging and satisfactory results. Each major investigation distinctly contributed to our knowledge of fish and the fisheries, and both the volume and the quality of such contributions were unusual.

The policy of stressing the study of the immediate rather than the ultimate causes of fluctuations in the abundance of fish of each species was continued. The practical value of the information resulting from such studies is being recognized more and more, and solicitations for further investigations of this nature are increasing; but in spite of larger appropriations for such work, it has been impossible to respond to all of these requests. While appreciation and support of the work of the division is distinctly gratifying, it is realized that such interest entails increased responsibility in addition to the greater opportunity for public service. Every effort has been and will continue to be made to meet this responsibility as ably as possible.

There has been no change in the policies of the division, as outlined in the reports for the past few years. The division of the work into major investigations has been continued, emphasis having been placed on those giving the greatest promise of results of practical importance in the conservation and development of our fishery resources.

[1] Appendix I to the Report of the United States Commissioner of Fisheries for 1926. B. F. Doc. No. 1003.

True conservation of such resources as the fisheries means not only guarding them against depletion but making use of them to the greatest possible extent compatible with their perpetuation. Experience with domestic animals has taught us that the normal production of individuals is in excess of the number required to maintain the species, and that man may spend this excess without exhausting the capital stock. Our experience with domestic animals shows further, however, that the amount of this excess stock varies from year to year. In some years production is especially good, and then a greater number of animals may be utilized; but in other years the excess production is negligible or the stock may drop even below the level of maintenance, due entirely to causes outside the control of man. Although not so clearly apparent, the same thing is true of stocks of wild animals, including fish.

The difficulty is to determine from year to year what the excess production is and how much of the stock may be taken by man without endangering the future supply. This is especially difficult in the case of fish, which are, for most of their lives, out of reach of direct observation. In the case of stocks of domestic animals, or even of wild land animals and birds, it is possible to determine with considerable accuracy their population and the increases in their numbers from year to year, but in the case of fish this is practically impossible. Yet information of this kind is just as essential for the proper care of our fishery resources as it is for the care of land animals, whether domestic or wild. It will take more effort and more time to determine the yield of our aquatic resources from year to year and the causes of the fluctuations in the yield, but this expenditure will be amply justified by the more intelligent care we will be able to give them.

A new branch of applied science, aquiculture, is being developed and may be expected eventually to include the care of our aquatic resources in much the same way that agriculture takes care of our land resources. The problems of aquiculture are the more difficult ones, perhaps, but it is certain, nevertheless, that this science must be developed as agriculture has been—on a firm foundation of scientific facts. We must know the causes of fluctuations in the yield from year to year and how these fluctuation may be controlled, if that be possible, if we are to increase the productivity of our water areas and maintain it at the highest level.

Cooperation with the bureau by the States in conducting investigations was continued with very satisfactory results. During the past year work was conducted in cooperation with the States of North Carolina, South Carolina, Florida, Texas, Michigan, Wisconsin, Washington, Oregon, and California, and additional work is planned for the immediate future. The States provided men, laboratories, boats, and other equipment, and by this means the division was able to extend its activities far beyond the limits set by its own appropriations.

Perhaps the greatest difficulty in the way of the proper development of the work of the division lies in securing properly trained men interested in fishery investigations. More investigators are needed on our own staff, and frequently we have requests from State organizations for trained men, yet the greatest difficulty is experienced in finding really qualified investigators. It is hoped that some

of our universities will take notice of this demand and train men qualified to undertake work of this kind.

Two important general conferences dealing with the scientific investigation of fishery resources were held during the year. The first of these was called by the Commissioner of Fisheries on January 9, at the solicitation of State authorities and private persons interested in the welfare of the oyster industry, for the purpose of considering the various problems confronting that industry. Producers and distributers of oysters and the various State shellfish commissioners were represented, more than 50 persons being in attendance.

The second conference was called by the Secretary of Commerce on May 22 to consider plans for saving certain of the important Atlantic-coast fishery resources from further depletion and ultimate commercial destruction. It was attended by representatives of the various fish commissions of the Atlantic and Gulf States. Among the subjects discussed were the fisheries for shad, sturgeon, and lobsters, the control of fisheries in boundary waters, and the destruction of undersized or immature fish. The conference requested the Secretary of Commerce to appoint, with the approval of the governors of the interested States, a commission to work out the various problems pertaining to the rehabilitation of the lobster, shad, sturgeon, and other fisheries of our coastal waters, and agreed as to the necessity for concerted action to prevent their further depletion.

The following progress reports, covering the more important investigations conducted by the division during the calender year 1925, were prepared, in the main, by the investigators in charge.

INVESTIGATIONS OF FISH AND FISHERIES

ATLANTIC COAST

LIFE HISTORIES AND MIGRATIONS OF COD, POLLOCK, AND HADDOCK

This investigation, which was begun in April, 1923, was continued during 1925, when 15,260 cod, pollock, and haddock were tagged in localities ranging from Petit Manan, Me., to southern Massachusetts. Many of these fish, as well as fish tagged in 1923 and 1924, were recaptured during the year, and data relating to migrations, rate of growth, and age with respect to size were collected. A statistical summary of the results gained from the tagging experiments is given in the following tables:

TABLE 1.—*Number of cod, pollock, and haddock caught, and rate of capture per hour, during the years 1923–1925*

	1923	1924	1925
Number of cruises	7	9	16
Days of actual fishing	43	51	76
Hours of actual fishing	333	318.5	461
Number of cod tagged	7,618	6,209	10,420
Number of pollock tagged	2,215	916	949
Number of haddock tagged	411	3,223	3,891
Total number of fish tagged	10,244	10,348	15,260
Average number of fish tagged per hour	30.76	32.5	33.1

TABLE 2.—*Catch of fish according to localities*

	1923	1924	1925
Rhode Island			1
Massachusetts south of Cape Cod	10,231	4,384	6,142
Massachusetts north of Cape Cod	13	163	314
New Hampshire		8	5
Maine		5,793	8,798
Total	10,244	10,348	15,260

TABLE 3.—*Number of recaptured fish reported up to December 31, 1925*

	Recaptured				Total for each species
	1923	1924	1925	Total	
Cod tagged in 1923	156	91	32	279	
Cod tagged in 1924		206	245	451	
Cod tagged in 1925			578	578	1,308
Pollock tagged in 1923	11	25	5	41	
Pollock tagged in 1924		4	20	24	
Pollock tagged in 1925			7	7	72
Haddock tagged in 1923		5	1	6	
Haddock tagged in 1924		14	34	48	
Haddock tagged in 1925			33	33	87
Grand total of recaptures					1,467

In addition to these there are 38 records of cod recaptured a second time. No marked pollock or haddock were caught more than once, with the single exception of pollock No. 16,418, which was taken a second and a third time.

The regions of Mount Desert and Platts Bank, Me., have proved to be of unusual interest as experimental tagging grounds. Platts Bank, an isolated ledge in the Gulf of Maine, has an area of about 35 square miles, a depth 29 to 50 fathoms, and hard bottom such as cod prefer. Except for the north prong of Jeffreys Ledge, 11 miles west, it is surrounded for many miles by soft bottom, which cod usually avoid, and depths of 60 to 100 fathoms. During June and July, 1925, 604 cod were tagged on Platts Bank, and by the middle of November 13 per cent of these had been reported recaptured. This relatively high percentage is remarkable when it is considered that almost all recaptures were made by several Portland vessels fishing there in October and November and by the *Halcyon* during 7 days' tagging.

Scale samples were taken from all cod tagged in 1925 as well as from miscellaneous fishes. Over 10,000 scales, each from a different fish tagged in 1924, have now been mounted for study. It is believed that an analysis of these scales will give valuable data on the age, with respect to size and rate of growth, of various stocks of cod, pollock, and haddock along the New England coast.

A preliminary report on the Nantucket Shoals cod is now in course of preparation. This is practicable because it has been found that the stocks of cod inhabiting this region have carried out migrations of the same sort from year to year and that their lives differ in several important respects from the lives of those occurring north

and east of Cape Cod. Consequently the Nantucket Shoals fish can be treated as a separate unit.

The outstanding results of the fish tagging up to December, 1925, were as follows:

1. Nantucket Shoals: Cod tagged here in 1923, 1924, and 1925 have migrated each fall to the shore waters of Rhode Island, Long Island, and New Jersey. A few have been recaptured in South Channel, and only stragglers were taken north of Cape Cod or on Georges Bank. The majority were caught on Nantucket Shoals where they were tagged.

2. Stellwagen Bank, Massachusetts Bay: From a small number of cod tagged on this bank, two recaptures were made off Cape Ann and two off Rockaway, N. Y. There is therefore an indication of a migration both north and south of Stellwagen.

3. Portland to Boothbay Harbor, Me.: Most of the recaptures made of these fish have been extremely local, but a few tagged cod migrated offshore to Jeffreys Ledge and Platts Bank. The exceptional recaptures were made, one each, at Dennis (southern Massachusetts), Stellwagen Bank, and Grand Manan, New Brunswick.

4. Platts Bank: There were recaptured 18.3 per cent of the 218 cod tagged here in 1924, and 13.1 per cent of the 604 tagged in 1925. All recaptures were local except three, one at Harpswell, Me., and two near Chatham, Mass. Therefore, no migration from this bank was noted, but the local intensity of the fishing with respect to the stock of cod evidently was great.

5. Mount Desert: Thousands of cod were tagged here in 1924 and 1925. Nearly all recaptures were made locally, but enough records were received to show that a small migration to the Bay of Fundy occurred. A single cod tagged here was recaptured on Nantucket Shoals, but this is the only record from below Cape Elizabeth, Me. Local fishing evidently was very intensive, for up to the 1st of December 31.8 per cent of 308 cod tagged in April, 1925, and 17.7 per cent of 1,303 cod tagged in May had been recaptured.

Information concerning the migrations of pollock is not sufficient to permit of definite conclusions. The 72 returns of fish tagged from 1923 to 1925 show that 60 were recaptured locally, in many cases a year or more after tagging, and 12 made long migrations. From Nantucket Shoals 4 tagged pollock were recaptured in South Channel, 1 on Georges Bank off Massachusetts, 1 on Cashes Bank, and 1 off Petit Manan, Me., and 3 in the lower Bay of Fundy, Canada. One Platts Bank pollock was taken at Burnt Island, Me., and one Jeffreys ledge fish was recaptured off Sable Island, Canada.

Of 87 haddock records, several were incomplete, 20 fish made long migrations, and the remainder were taken locally. From Nantucket Shoals 8 were recaptured in South Channel, 1 on Georges, 3 on Stellwagen Bank, and 1 on Platts. From Boothbay Harbor, Me., 1 haddock migrated to Platts, and from Mount Desert 2 were taken in New Brunswick, 3 on Platts Bank, and 1 in South Channel adjacent to Nantucket Shoals.

This work was efficiently conducted by W. C. Schroeder under the general direction of Dr. H. B. Bigelow of the Museum of Comparative Zoology, Harvard University. It is planned to continue the investigation during 1926, when offshore fishing banks, as well as the usual shore grounds, will be fished.

Throughout the past year the investigations of the spawning grounds and early development and distribution of young cod, pollock, and haddock in New England waters were continued by Dr. Charles J. Fish and Marie P. Fish assisted by Robert A. Goffin. Particular attention was given to Massachusetts Bay in order to determine its value as a production area for cod. Fourteen cruises were made on the *Fish Hawk*, covering the area between Ipswich Bay and Provincetown. At 41 stations, physical observations were made and fish eggs, young fish, and plankton were collected, counted, and identified. Drift bottles were used to determine current movements. The results so far indicate that a very definite and constant counterclockwise drift carries out all cod eggs spawned in Massachusetts Bay before they hatch. Throughout the breeding season eggs were found in abundance, particularly about the Plymouth grounds, but the collections of 14 cruises failed to yield a single young cod. Charts based on the distribution of eggs in various stages of development show clearly the spawning centers and the drift of the eggs, the greater proportion of late stages having been taken about the Provincetown region as they were leaving the bay.

The records of drift-bottle discoveries also substantiate the above conclusions. Of 141 set out during the year, 43, or 30.5 per cent, were returned. On February 6 and 7, 90 were set out and 19, or 27.7 per cent, were recovered within a few days along the inner arm of the cape, having followed the circulatory drift until they grounded. Most of them entered Provincetown Harbor. Three escaped the cape and appeared on the Nova Scotian coast between July 2 and August 27. Two circled the cape and were found on the south shore of Nantucket. No record has been received of 11 placed north of Massachusetts Bay between Cape Ann and the Isles of Shoals on April 7. On May 20 to 22, 40 were again set out in the area covered in February. A line also was added along the north shore from Cape Ann to Boston and one from Cape Ann to a point off Provincetown. Of the 10 placed along the northern shore, 5 were recovered, all having soon reached the beach after drifting in a southerly direction. Of the 10 placed along the outer entrance to the bay, 2 were recovered. Apparently they had circled into the bay and grounded on their way out. One reached shore near Race Point on the outer tip of Cape Cod, and the other was taken drifting 2 miles from land, having successfully passed the cape.

Of the 20 placed in the bay, 11 were recovered. One had traveled from the inner edge of Stellwagen Bank to a point 75 miles S.E. by S. of Highland Light, Provincetown; while another, starting far within the bay, reached Edgartown on Marthas Vineyard. All of the bottles clearly indicated the circular drift into the bay from the north and out to the east. There, apparently, a division takes place, part moving north toward Nova Scotia and part south around Cape Cod.

As the lack of a suitable ship prevented an extension of the survey to the outer waters to determine the fate of the cod eggs after leaving the bay (the next logical step in the program), a continuation of the work of the past year was decided upon to serve as a check on the previous observations. Monthly cruises are being made, covering much the same area as last year, except that stations

have been added as far offshore as possible and a line extended from Cape Ann to Boston to determine, if possible, the quantity of eggs that enter the bay from the north.

An important point in the present investigation is to determine whether the past year was a normal one or whether unusual physical conditions were responsible for the total absence of young cod throughout the breeding season. It was interesting, therefore, to find that the water temperatures during the first cruise (December 15 to 19, 1925) were almost identical with those taken over the same period last year. The cooling apparently took place at the same rate in each year.

TABLE 4

Massachusetts Bay	Dec. 16 and 17, 1924	Dec. 15 to 19 1925
	°C.	°C.
Average surface temperature	5.02	4.83
Average bottom temperature	5.46	4.88
Warmest station (surface)	5.93	5.60
Warmest station (bottom)	6.10	5.80
Coldest station (surface)	3.80	2.80
Coldest station (bottom)	4.20	2.80

Due to the absence of young cod in the collections, no information was obtained as to their food and enemies. The physical conditions necessary for the successful hatching of cod are fairly well understood, but almost nothing is known about the biological environment of the cod and its relative importance in determining success or failure in any particular season or locality. Experiments along these lines are being conducted with larval fish obtained from the hatchery at Gloucester.

In addition to data concerning the cod, pollock, and haddock, the present investigation has increased our knowledge of the distribution, life histories, and occurrence, in the area covered, of 23 other species of young fish that have been identified from the collections.

MACKEREL INVESTIGATIONS

During the 1925 mackerel fishing season, investigations on this important fishery were begun. These consisted principally of tagging experiments and the collection of biological data and material such as scales and records of size and maturity for future analyses. Much of this work was carried on in cooperation with the division of fishery industries, which has begun a program intended to accumulate special statistics on fluctuations of the mackerel fishery.

The tagging experiments were carried on at Provincetown, Woods Hole, and Casco Bay, approximately 5,600 mackerel being tagged during the season. Of these, 286 have been reported as recaptured, some of them having been taken as far east as Fire Island, N. Y., and as far north as Casco Bay. Any general conclusions as to the migrations of mackerel, however, must await the extension of these operations in future years.

Mullet investigations.—The investigations of the mullet in the South Atlantic States was continued during 1925 by Elmer Higgins, director of the Key West biological station, and several assistants. John C. Pearson, Russell F. Lord, and Robert O. Smith were employed in this work at various times during the year and later were assigned to other problems.

The mullet fishery, yielding approximately 40,000,000 pounds of products annually, is widely scattered, being prosecuted with varying intensity from North Carolina to Texas. The fishery has seriously declined in several areas, notably North Carolina, and is in need of conservation. Because of the nature of the fish, local conditions are of unusual importance, but on account of the lack of sufficient funds to properly conduct so extended an investigation, it was necessary to center activities at one shore station only and to conduct studies of a fundamental nature having bearing upon the whole fishery. These studies included racial localization, migrations, growth, age, and racial analysis of the local stock of fish.

The question of racial localization is of practical importance to the regulation of the fishery. Previous work has shown that mullet from North Carolina and Florida differed to a significant extent in measurements of the heads, indicating the existence of distinct races and an absence of the extensive migrations commonly attributed to these fish. Over 7,000 additional measurements made in 1925 on the North Carolina stock agreed completely with previous observations and added to the evidence already collected.

Additional data on the so-called Cape mullet strengthen the assumption that these fish are a distinct division of the local stock because of a different variation in the measurements of the head and higher rate of growth. This question is complicated by migrations and other factors, however, and must be investigated further during the coming spring and summer before definite conclusions can be reached.

Migrations of the mullet have been studied by observing the composition of the local population during each month of the year, by collecting records of the commercial runs, and by the liberation of tagged fish. Commercial catches and special hauls were sampled throughout the year, the catch was analyzed for age and size composition, and physical measurements were taken. In all, approximately 4,800 mullet were measured during 1925.

The records of the commercial runs of fish were collected for 1924 by personal canvass of the principal dealers of North Carolina, but as this method of obtaining records was unsatisfactory, those for 1925 were collected by weekly questionnaires. It was considered desirable to test the popular belief that the runs of mullet depend upon weather conditions. The imperfect catch records of 1924, when compared with temperature records, showed a high degree of negative correlation, and it is expected that details of the effect of temperature and other weather conditions upon the movements of the fish can be worked out from the more accurate records of 1925.

Although the analyses of the racial stocks of Florida and North Carolina have progressed far enough to convince the investigators of the falsity of the popular views on the extent of migrations, it was

thought best to test these preliminary findings and provide an objective proof of the wanderings of the mullet. Accordingly, a tagging experiment was undertaken, and 3,000 mullet were tagged and liberated near Beaufort, N. C. About one-third of the fish tagged were in their first year and the rest were in their second. By the end of December, 34 tags had been returned by fishermen.

TABLE 5.—*Summary of mullet-tagging experiments*

Month	Number tagged	Number returned	Locality of recapture		
			North of Beaufort	At Beaufort	South of Beaufort
June	994				
July	702	11	3	8	
August	231	7	3	3	1
September	584	10	3	2	5
October	516	5			5
November					
December		1	1		
Total	3,027	34	10	13	11

All tagged fish were recaptured within the boundaries of North Carolina except one near Georgetown, S. C., 170 miles from Beaufort. This fish traveled the maximum distance from the place of liberation and did so in 52 days. The longest time that elapsed between liberation and recapture was 119 days. While these returns are insufficient to outline fully the migrations of the mullet, the indications are that the southward migration along the coast begins, at Beaufort, in August, continues during September, and is completed in October. Some fish, however, remain in fresh or brackish waters of the rivers during the winter, apparently not taking part in the annual migration. These observations are in accord with popular opinion in this district. The experiment further indicated that North Carolina mullet do not continue the journey to Florida, as is generally supposed, but definite conclusions as to the extent of the migrations must be withheld until further data are available. It is planned to extend the tagging experiment another year to Florida waters.

Material progress has been made in the study of the growth of the mullet. Evidence has been gathered from a study of monthly curves of length frequency, from the study of scales, and from the tagging experiment. It has been found that the supposed typical North Carolina stock reaches a body length of approximately 150 millimeters in the first year and nearly 300 millimeters in the second. The maximum age is probably 5 or 6 years. Growth begins in May and extends into October. Certain discrepancies in the various data are probably due to the mixing of distinct racial stocks, and it is hoped that these and other details may be worked out from scale studies that are now under way.

Analyses of the commercial catch at Beaufort show that the July, August, and September catches consist of second-year fish (the I group) and that October runs are mainly composed of either older fish of the third or fourth year, which are approaching the spawning condition, or else of fish less than one year old (the O group). In 1924 the older fish (II and III groups) predominated, but in 1925 the

cape mullet, all of the O group, were exceedingly abundant, and an unusually large catch was made during the season. This seems to indicate that great fluctuations in yield may result from natural causes, and that the phenomenon of dominance of year classes, so clearly recognized in other fisheries, may be of equal significance and practical importance in the case of the mullet.

While there are many indications that the mullet fishery of North Carolina has reached an advanced stage of depletion, the problem of adequate protection is extremely complicated. Because of the uncertainty as to the origin and identity of the individual stocks in these waters and their relative need of protection, no definite recommendations for regulation of the fishery have been offered. It is hoped, however, that a practical plan can be devised during the coming year.

Investigation of the summer fisheries of Pamlico and Core Sounds, N. C.—At the request of the State fisheries commisssioner, an investigation of the summer fisheries of Pamlico and Core Sounds, N. C., was undertaken to determine the action upon the fish stock of the two chief types of gear in use in these fisheries—namely, pound nets and long-haul seines. Five fishing stations were chosen at which to conduct the investigation, where unsorted samples of the catches made were analyzed once each week from June 8 to November 3, 1925. John C. Pearson, temporary assistant, performed all of the field work and studied many of the data under the supervision of Elmer Higgins.

It was discovered that of the two species that formed the greater part of the catch in pound nets (gray trout and harvest fish), about half were below the legal or marketable size limit. The greatest waste of gray trout occurred during June and July, when 54 and 30 per cent, respectively, were below the legal limit of 9 inches. The greatest waste of harvest fish, however, took place in August, September, and October, 65, 95, and 97 per cent, respectively, being below market size then. Of the two chief species caught by long-haul seines (spotted trout and croakers), practically no destruction of unmarketable fish occurred until October, when 14 and 13 per cent, respectively, were destroyed.

The total yield of the sea trouts in 1923 amounted to 28.3 per cent of all marine food fish in North Carolina, perhaps 90 per cent of these being gray trout caught by pound nets, The catch of harvest fish, however, amounted to only 3.7 per cent. No single system of protection for both of these species has been discovered so far, hence it was decided to recommend the establishment of a closed season until August 1 on all pound nets fished in the sounds, for the protection of the more important species. As the gray trout has practically completed its spawning by this time, the closed season prohibiting the destruction of unmarketable fish would afford almost complete protection.

A preliminary report dealing with these data was prepared and presented at the meeting of the State Fisheries Commission on December 8. Acting on the information contained therein, the commission passed a rule establishing the closed season as recommended. The promptness of this action on the part of the State is most encouraging, and it is believed that much good will result.

Investigation of the marine fisheries of Texas.—A growing belief that complete depletion of the Texas marine fisheries is imminent has resulted in demands for an investigation to determine the causes of the present shortage of the fish supply. Accordingly, the work was undertaken, and Elmer Higgins and Russell F. Lord, junior aquatic biologist, visited the Texas coast during July and August for the purpose of conducting a preliminary survey of the fisheries as the basis for further plans. A report was prepared and submitted, describing the fisheries, discussing past and present conditions as discovered by a study of all available records, summarizing the present knowledge of the habits of commercial species, outlining the need for biological research, and recommending changes in the method of fishery administration.

The report especially emphasizes the lack of records competent to show the real state of the fishery, and recommends the adoption of a system of statistics that will be of economic value and also provide the basis for a biological examination of the abundance of fish. Necessary changes in the administrative machinery to permit the development of a rational program of conservation also are outlined.

Robert O. Smith, temporary assistant, was detailed to the field work on November 18, and headquarters were established at Corpus Christi, Tex., where a biological examination of the commercial fishery was begun with special reference to the question of depletion. In addition, the life histories of the chief commercial species—redfish, spotted sea trout, and black drum—will be studied with the view of discovering adequate and equable methods of protection.

The cooperation of various States in the investigations of fisheries of the South Atlantic and Gulf States has been most gratifying. North Carolina has contributed to the mullet investigation by supplying a 26-foot open launch for the the exclusive use of the investigators from May to November. The investigation of the Pamlico Sound region was made possible by the furnishing of a comfortable and seaworthly 40-foot cabin cruiser and crew with all expenses paid for its operation from June to November. Half of the expense of purchasing samples of fish also was borne by the State.

SMELTS AND SALMONIDÆ

Early in the year, Dr. William C. Kendall completed and submitted for publication a report upon the natural history of the smelt (Osmerus) and a synopsis of both salt-water and fresh-water smelt fisheries of Atlantic waters, particularly those of North America and more especially of the United States, to which are added discussions of smelt culture and conservation. The section of the report concerning the natural history of the smelt comprises both a compilation of data scattered through many publications and records from the author's personal observations during more than 30 years. In making the compilation it was somewhat surprising to find that there was so little published information concerning the habits and life history of the smelt. The natural history account pertains to both salt and fresh-water smelts and comprises discussions of geographical distribution or "range," habitat, size, food, breeding habits, enemies, etc.

Concerning the smelt fisheries of the eastern United States and Canada, it is shown that the fishery of the United States has progressively declined in quantitative importance from the southern limits

northward, so that at the present time Maine has virtually the only commercial smelt fishery of the Atlantic States, and even that has greatly fallen off in recent years. It is also shown that most of the smelts consumed in this country come from the Canadian Provinces, principally from New Brunswick. In this connection the smelt fisheries of Massachusetts, Maine, and Canada are historically discussed and compared, and from the comparison it appears that while the smelt fishery of the United States shows a marked decline, that of Canada has greatly increased in economic importance. Some of the causes to which the decline in the United States is attributed are as follows:

1. Lack of effective regulation of methods, time, and places of fishing.
2. Lack of protection of the fish during the breeding season and failure to protect immature smelts.
3. Physical and chemical obstructions to the ascent of streams for spawning.

Doctor Kendall has also been occupied with the preparation of a paper pertaining to the life history of the smelt as revealed by scale studies and measurements of specimens and has studied hundreds of scales and specimens. The question of species and races of smelts is also being considered.

Scale readings of marine smelts indicate that such fish first spawn at the age of 2 years and that the great majority of smelts that ascend the streams to spawn are of that age. Three-year fish are less common, those four years old still fewer in number, and five-year fish are comparatively rare. For example, of 1,000 smelts taken in the same brook in two successive years (1924 and 1925), 896, or nearly 90 per cent, were 2 years old; 75 individuals were 3 years, 25 were 4 years, and 4 specimens appeared to be 5 years of age. In October and November, 1925, 70 out of 132 smelts taken at random from a dealer in 1 and 2 pound lots, or something over 50 per cent, were in their second year; 59 individuals were in the third, 2 in the fourth, and 1 in the fifth year. Had these fish lived until the next spring they would have reached exactly the ages of 2, 3, 4, and 5 years.

In the report concerning the conservation of the smelt fishery, Doctor Kendall expresses the belief that if the fish were to be adequately protected and the fisheries properly regulated, the fishery in Maine might be rehabilitated to a great extent.

Analysis of various data, of which the foregoing figures are an example, leads to the conclusion that the maximum productivity to which the smelt fishery can be brought depends largely upon the undisturbed breeding of 2-year-old smelts, and this depends upon the attainment of that age by the immature smelts. In the smelt fishery great quantities of immature smelts are destroyed, and it is impossible to prevent this destruction as long as certain prevailing methods of fishing are employed; but the destruction may be reduced to a minimum by establishing refuges where no smelt fishing except by hook and line will be permitted. Accordingly, Doctor Kendall recommends that all smelt fishing, except by hook and line, be prohibited in tidal waters such as arms, coves, creeks, etc., one-half mile or less in width. It is furthermore advised that the closed season for breeding smelts begin March 1.

In Maine, fresh-water streams flowing directly into tidal water come under the jurisdiction of the Inland Fish and Game Commission instead of the Sea and Shore Fishery Commission, and the law permitting fishing for fresh-water or lake smelts during their breeding season applies on these streams. As smelts can breed only in fresh-water streams, the marine smelt is afforded no protection during the spawning runs. A law should be made distinguishing between tide water and lake tributaries, and the protective law of the Sea and Shore Fishery Commission should be extended to cover the former.

The analysis of the data pertaining to the fresh-water smelts is still in progress. The smelts of the lakes afford entirely different problems from those of the salt-water fish, and it is anticipated that these will be worked out, as far as the data will permit, in the near future.

LARVAL FISHES

An unusual opportunity was afforded by the *Arcturus* expedition (see account under heading "Oceanography") for the study of larval fishes, their distribution over large areas in the Atlantic and Pacific Oceans, their embryology, food, and enemies, the description of unknown forms as well as of new stages of known species, and a study of the conditions of life under which they exist in the open sea. The examination of the young fishes collected by the expedition is being carried on by Marie Poland Fish.

Throughout the cruise, larval and postlarval fishes were found distributed everywhere over the ocean, but the number of species and the actual abundance of specimens were strikingly different in the various regions investigated. From Bermuda southward, in the Sargasso Sea area, every haul of the plankton nets and Petersen trawls yielded quantities of young fishes, often 10 to 20 species at a time. Although this part of the Atlantic had been visited by heavy storms for some weeks, the larval fishes seemed to thrive well, if one can judge from the immense number of uninjured specimens taken. It would appear, also, from the collections made here, in a region where conditions typical of the open sea exist, that by far the greatest proportion of ocean fishes spend the early part of their lives at the surface. Of 40 species recorded and described by Mrs. Fish in late February and early March, approximately 80 per cent were found always at the surface, 10 per cent at depths of 100 to 200 meters, and 10 per cent below these depths.

The Pacific Ocean, in contrast to the Atlantic, although swarming with animal life, yielded relatively few larval and postlarval fishes from March until the middle of June. Although nearly every haul brought in a few larvæ, and the number of species represented over the whole period was no less, the total number of specimens was much smaller than in the Atlantic during late February, March, and July.

The embryology and early development has been worked out for five species of flying fish obtained during the cruise, some of them from nests of Sargassum weed bound together by tough threads of secreted material. The unusual modification of the fins was found to be evident even in the egg. The eggs of 15 different fishes, the development of which was previously unknown, were hatched in the laboratory. At the completion of the expedition, 161 species

of larval and postlarval fishes had been figured and described by Mrs. Fish, and further study of the collections undoubtedly will reveal many more.

In connection with the work on tropical larval fishes, it has been possible to identify many of the extensive collection of larval fish slides made for the bureau by the late W. W. Welsh.

CHESAPEAKE BAY

The report bearing on the fish and fisheries of Chesapeake Bay, which is being prepared under the direction of Dr. Samuel F. Hildebrand, assisted by William C. Schroeder, Isaac Ginsburg, and Irving L. Towers, has been virtually completed and will be submitted shortly for publication. A total of 107 salt and brackish water fishes, of which 3 appear to be new, are described and discussed therein. The descriptions in the report, with comparatively few exceptions, were drawn up directly from specimens. Whenever specimens were not available and descriptions were compiled or copied from published accounts, it was so stated. Keys for families, genera, and species are included. A special effort was made in the discussion to point out the most evident field marks distinguishing the various species. Brief accounts of the food and feeding, spawning and life history, size attained, relative abundance, and commercial importance of each species are included. A considerable number of graphs showing the fluctuations and relative abundance over a period of years for several important commercial species also have been prepared.

NORTH AMERICAN COMMITTEE ON FISHERY INVESTIGATIONS

Two meetings of the committee were held during the calendar year 1925, one in May and the other in November. The first one was held at New York on May 8, and W. A. Found, A. G. Huntsman, and J. P. McMurrich, representatives of Canada, and H. B. Bigelow, Henry O'Malley, and Willis H. Rich, representatives of the United States, were present. In addition to these, J. P. Babcock, of British Columbia, N. B. Scofield, of the California Fish and Game Commission, F. W. Wallace, of the Fishing Gazette, New York City, and O. E. Sette, of the Bureau of Fisheries, were in attendance.

The principal matter under consideration was the planning of proper methods for the collection of statistics of the fisheries on the banks of the western North Atlantic, with particular reference to the mackerel, cod, and haddock. Suggestions were made for improving the present collection of statistics, and a special committee was appointed to consider the details more fully. The program of the United States Bureau of Fisheries in studying problems of the cod fishery, with particular reference to the spawning of the cod in Massachusetts Bay, and the movements of the adults by means of tagging experiments was outlined. The project of tagging mackerel also was discussed, and it was urged that further steps be taken to investigate the Atlantic halibut.

The second meeting was held at Montreal on November 6, W. A. Found, A. G. Huntsman, and J. P. McMurrich, of Canada, and H. B. Bigelow and O. E. Sette, of the United States being present.

The importance of securing the interest and cooperation of all nations participating in the fisheries on the American side of the North Atlantic was discussed. The committee decided to extend an invitation to membership and representation on the committee to Portugal, and the Canadian Government was asked to communicate with Portugal that effect. Participation by Portugal would round out the representation on this committee, which already includes Newfoundland, France, Canada, and the United States. All of these countries participate in the fisheries of the American North Atlantic, which yield in excess of 1,000,000,000 pounds annually.

The special committee appointed at the previous meeting to consider recommendations for the improvement of statistics of the fisheries reported its recommendation that statistics be collected so as to make available information on the fishing effort, as shown by the number of men and the number of fishing days involved in the production of the total catch. These recommendations were approved by the committee.

Action was also taken to secure the cooperation of each country in transmitting annual reports of its statistics to the other members of the committee.

It was also recommended by the committee that there should be regular collection of data and material of the commercial fisheries in the form of measurements and scale collections from sample catches.

The progress during the past season in cod, haddock, and mackerel investigations and the drift-bottle experiments were reported to the committee.[2]

INTERIOR WATERS

COREGONINÆ OF THE GREAT LAKES

Dr. Walter Koelz has completed the first draft of a report on the systematic relationships and natural history of the coregonines of the Great Lakes and Lake Nipigon, and it is hoped that the manuscript will be ready for publication soon. Experiments also have been begun to test the constancy of racial characteristics in the lake herring. The superior quality of the Lake Erie herring has long been recognized by the trade, and a great deal of interest has been manifested in its introduction into other lakes. Fry have been liberated in Saginaw Bay in Lake Huron, and at Port Washington, Wis., in Lake Michigan. If the fish retain the characteristics they exhibit in Lake Erie, the experiment will have important consequences. Additions have been made to the collections of coregonines from the inland waters of eastern North America, principally through the courtesy of the Department of Biology of the University of Toronto, the museum of the University of Michigan, and the State museum of New York.

During the past year John Van Oosten spent much time in revising and greatly elaborating a paper on the life history of the lake herring (*Leucichthys artedi*) of Lake Huron. The new data were derived from a study of some 2,000 additional specimens and scales collected in 1924 and referred to in the last annual report. Altogether, some 4,000 herring and their scales, representing samples taken

[2] The details of the work of the United States Bureau of Fisheries on these subjects may be found on pages 3 to 7 of this report.

each year since 1921, have been measured and studied. From this series of samples it has been possible to follow the history of the commercial schools and year classes of herring through several successive years and to obtain a rather detailed life history of the species, and questions of importance were definitely settled. The data furnish information on a number of problems, such as the age composition of various commercial schools, the average lengths and weights of males and females at various ages, the variations in rates of growth, the norms for growth, the abundance of males and females, the age at sexual maturity, the races of herring, the effects of commercial fishing upon the fish stock, etc. The report will be submitted soon for publication.

Some progress has also been made during the past year in the study of the life history of the Lake Huron whitefish (*Coregonus clupeaformis*), but it is thought best to withhold a report until all the available material has been studied.

As in previous years, several weeks were devoted to the collection of additional herring and whitefish material.

PACIFIC COAST AND ALASKA

An outstanding feature of the work on the Pacific coast in 1925 was the establishment of the International Pacific Salmon Investigation Federation, organized at a meeting held in Seattle, Wash., on March 16 and 17 and attended by Federal and State fishery officials representing the United States, Canada, British Columbia, Alaska, California, Oregon, and Washington. A permanent organization was effected, pledged to the development of a cooperative plan for the study of the problems of production and building up the salmon runs. The following statement is quoted from the account of this meeting given in the Pacific Fisherman for April, 1925.

> The most important subject taken up was that of biological investigation. It was admitted that the existing knowledge of the salmon is far less than it should be; and a review of a few of the vital points on which there is no accurate knowledge whatever indicated the vast extent of ignorance on the subject that still exists * * *. The ground to be covered would include fish-cultural problems and other possible means of increasing the production of salmon as well as other questions concerning the life and habits of young and mature fish. It was decided that a definite plan should be developed for organized work along this line, details of which were delegated to a committee.

In carrying out its part of the program, the bureau has established a laboratory in Seattle in quarters kindly provided by the University of Washington, and Dr. W. H. Rich has been placed in direct charge of the salmon investigations. Another meeting of the executive committee of the federation, of which Commissioner Henry O'Malley is chairman, was held in Seattle on November 24. At this time Dr. C. H. Gilbert, Dr. W. A. Clemens of the Biological Board of Canada, Doctor Rich, and others presented their views relative to the proposed program of salmon investigations. Definite plans were presented for research work to be carried on during 1926.

The organization of this federation marks a distinct step forward in salmon investigations and will bring about a coordination of activities, which would do much to make our research program more complete and to hasten the collection of data of vital importance.

ALASKA SALMON

The investigations of the Alaska salmon conducted by Dr. C. H. Gilbert and Dr. W. H. Rich have yielded important information during the past year. The study of migrations by means of tagging experiments was continued, nearly 16,000 tags having been attached. Two thousand of these were put on in the Port Moller region of the Bering Sea, the remainder being used in southeastern Alaska. The results of the experiments conducted at Port Moller corroborated the findings of 1922 to the effect that the majority of the fish taken at that place are of local origin, spawning mainly in the Bear and Sandy Rivers. The experiments in southeastern Alaska furnished much information regarding the migrations of the various species of salmon among the complicated channels of this region, but the situation here is so complex that it is not possible to summarize the results briefly. During the year a report was published covering the results of tagging experiments in 1923, and a report on the tagging experiments of 1924 and 1925 is in course of preparation.

The intensive study of the important salmon runs at Karluk, Chignik, and the red-salmon streams of Bristol Bay has been continued by Doctor Gilbert. Weirs have been operated continuously since 1921 at Karluk and since 1922 at Chignik, and during each of these years the escapement of salmon to these streams has been determined by actual count of the fish passing through the openings in the weirs. Weirs have been maintained at Alitak and in Anan Creek also. The first returns from escapements of known size will occur on the Karluk River in 1926 and at Chignik in 1927. The results are awaited with much interest, and we can look forward to a series of determinations in successive years that should present evidence of the highest value. Through these investigations an attempt is being made to determine such correlations as exist between the number of spawning fish and the number of their progeny that return at maturity. This will give a measure of the total losses that occur from the egg to the adult from all causes combined, and will answer the all-important question as to the size of the spawning reserve needed to produce a run of the desired size.

Rapid progress has been made by Doctor Gilbert in the survey of the cycles and the annual composition of the red-salmon runs to the various streams of Bristol Bay. Extensive collections of scales from this region have accumulated and represent the runs of several years. The scales of some 15,000 red salmon included in these collections were read during the past year and the results tabulated.

SALMON OF THE PACIFIC COAST STATES

A series of salmon-marking experiments, which have been conducted for a number of years on the Columbia River by the bureau in cooperation with the Oregon Fish Commission, yielded valuable information during the 1925 season. Approximately 100 adult chinook and 50 sockeye salmon, which had been marked by removing certain of their fins when they were liberated from the hatcheries, were recovered as they returned to the Columbia River to spawn. The sockeyes represent the first returns from 100,000 yearlings that were marked and liberated during February, 1924. The recovery

of so large a number of 3-year-olds gives promise of exceptionally good returns from the experiment. The fish in another sockeye experiment, in which the young fish were liberated during the fall of their first year, should have been 5 years old in 1925, but no returns were received. This experiment seems to have been a total failure, as no 3 or 4 year olds were recovered. These results agree with those from former experiments in showing that when it is not possible to liberate sockeyes in a lake in which they can remain until the spring of their second year (which is their natural time of migration), they should be held in rearing ponds until that time.

About 50 of the marked chinooks recovered were 3-year-olds that had been marked at the Big White Salmon River hatchery during May and June, 1923, when they were about 5 months old. Here, also, the recovery of a large number of 3-year-olds gave promise of good returns as 4 and 5 year olds. This one year's returns from this experiment nearly equal the total returns from two former experiments, which differed from this one mainly in that the fingerlings were retained for about three months longer before being liberated. The greater returns from this experiment would indicate that the best time to liberate the chinooks that spawn in the Little White Salmon and Big White Salmon Rivers is during the spring of their first year. This is to be expected, for a study of the scales of the fish that spawn in those tributaries has shown that normally they migrate to the ocean within a short time after hatching.

In order to determine the best time to liberate fingerlings of the spring run of chinook salmon, a series of marking experiments was undertaken in 1925 at the McKenzie River hatchery. This series consisted of five markings with liberations ranging from May of the first year to March of the second.

In addition to conducting the marking experiments on the Columbia River, H. B. Holmes has been making a study of the blueback salmon of the Columbia. Representative samples of scales and measurements were collected from the commercial catch at intervals throughout the season, and observations were made of the seaward migrants and the spawning adults in the Okanogan River spawning district.

HERRING OF ALASKA

In the spring of 1925 a biological investigation of the herring of Alaska was begun by George A. Rounsefell, scientific assistant. During the summer a preliminary survey was made, and as many herring establishments as was possible were visited in the season, touching at Ketchikan, Craig, Killisnoo, and Port Walter in southeastern Alaska; Sawmill Bay, Prince William Sound, Seldovia, Cook Inlet, and Red Fox Bay; and Kodiak and Three Saints Bay in the Kodiak district. As a necessary preliminary to other work, a study was begun to determine what local races exist and the degree of variation between them. Racial samples were collected at many of the points visited, and various structural characters were studied. These data show clearly that the Pacific herring is not a homogeneous population.

The average vertebral count falls from 52.78 in Prince William Sound and 52.72 in Shuyak Strait to 52.50 in Cook Inlet, 52.45 in

southeastern Alaska, 51.78 in British Columbia, and 50.81 in California. This is an average difference of two vertebræ between 60° and 37° of latitude.

The proportion between the head length and the body length (without caudal) decreases as the body length increases. Conversely, the proportion between the anal fin insertion and the body length increases, demonstrating that the head and tail do not keep pace with the rest of the body in growth. On plotting the head length the curves show great differences, the percentage of head to body length curve for Russian Harbor falling 2½ per cent below the curve for southeastern Alaska, at 255 millimeters body length. Other characters used are the dorsal and anal fin ray counts and the distance parallel to the body from the tip of the snout to the end of the occipital bone on the back of the head, and to the dorsal, ventral, and anal fin insertions. These characters also show differences of undoubted statistical significance.

It may be stated, from what few data have been collected, that the herring of southeastern Alaska are quite distinct from those to the westward. There are decided differences between localities in southeastern Alaska although in general these are less than the differerences between southeastern Alaska and the districts to the west. The same is true of localities to the west. There are slight indications, from rough measurements, that the phenomenon of the dominant year class may be present, as in the Atlantic herring and the California sardine, but this requires corroboration.

Scales were collected from all of the samples measured and are now being examined to determine the age and rate of growth in each region. This may also shed more light on local races.

MARINE FISHES OF THE GULF OF VENEZUELA

A fairly representative collection of fishes of the Gulf of Venezuela was received during the year from Commander Paul P. Blackburn of the U. S. S. *Niagara*. This collection was turned over to Dr. Samuel F. Hildebrand for study. Doctor Hildebrand, assisted by Irving L. Towers, has made some headway in the classification of the species.

It is of interest to note that several species ranging both north and south of the Isthmus of Panama, as for example the bluefish, are well represented in the Venezuelan collection but were not present in the extensive collections made on the coast of Panama by Meek and Hildebrand.

INVESTIGATIONS OF SHELLFISH AND TERRAPIN

OYSTERS

Investigations relating to oyster culture were conducted by Dr. Paul S. Galtsoff in Georgia and at Woods Hole, Mass., and by H. F. Prytherch at Milford, Conn.

A survey of the oyster resources of Georgia, made in January, February, and March, covered 351 miles of the Atlantic coast between Savannah and St. Marys, and was made for the purpose of determining the degree of depletion of the natural oyster beds and what practical measures are necessary in order to increase the production of oysters in the State.

The natural oyster beds in Georgia are situated either along the shores of the rivers above low-water mark or in the open sounds. These beds are in the form of large reefs, composed chiefly of long, narrow oysters (the so-called "coon" oysters) of inferior quality. The bottoms of rivers in the tidewater region present a great variety of conditions from very soft mud, unsuitable for planting, to hard, sticky, blue mud suitable for oyster culture. Many of the natural oyster beds that are easily accessible and are situated in shallow water have become depleted. In many places nothing remains but shells; in others even the shells either have been taken away or are covered by silt. On the other hand, the abundant oyster larvæ present during the spawning season cause a very heavy set and overcrowd every suitable object above low-water mark. One of the remarkable peculiarities of the Georgia oyster beds is the fact that sets are never found below low-water mark. Insufficient cultch is responsible for crowded conditions on the beds and the formation of "bunch oysters", but there is nothing to prevent the production of the best type of oyster in Georgia waters by transplanting seed oysters to deep water. The survey shows that the extensive coastal waters of Georgia are suitable for oyster culture and can be exploited with profit.

The following specific recommendations for the development of the oyster industry in the State were based on this survey:

1. Existing laws with respect to returning shells to the natural oyster beds, including supervision thereof and control as to time and place of planting, should be strictly enforced.

2. Small-scale experimental oyster farming should be developed at once. It was suggested that brush or shell be scattered between tide marks on several particularly favorable sites in order to obtain set, and that later the seed oysters be transplanted below low-water mark. These beds should be kept under constant observation, and salinity and temperature records should be taken at least once weekly.

3. Seed or adult oysters should be planted on depleted beds in order to restore them, and these beds should then be closed to fishing by the public for at least two years.

4. New oyster beds should be established in suitable localities above low-water mark.

In the summer and fall of 1925 experiments were conducted by Dr. P. S. Galtsoff at Woods Hole, Mass., to determine the effect of temperature on the feeding of oysters. With apparatus built especially for this purpose, it was possible to measure accurately both the rate of flow and the volume of water passed through the gills. It was found that sucking water is a function of temperature. The water reaches its maximum flow at 77° F. and retards with the lowering of the temperature. Below 45° F. no current is produced, although the cillia of the gill epithelium continue to beat; at 41° F. all motion ceases.

These observations furnish direct evidence on the much discussed theory of hibernation advanced several years ago by the bacteriologists, Prof. F. P. Gorham and Dr. H. D. Pease, who made the interesting statement that during the cold season the bacillum coli scores or ratings of oysters taken from the polluted beds are always very low. The present experiments show that this is because no water is taken in by the oyster when the temperature is low.

By analyzing the water that had passed through the oysters' gills, Doctor Galtsoff discovered that over 99 per cent of the diatoms and dinoflagellates consumed by them are caught by gill the epithelium. The discharged water contains almost nothing but mucus. However, the experiments made by him in October in Doctor Pease's New York laboratory show that only a very few bacteria are retained by the gills, most of them passing through the gill cavity. Bacillum coli alone were used in the experiments. It is believed that these laboratory e periments will be effective in solving the various practical problems of oyster culture and sanitary control of the oyster industry.

In order to determine which are the best methods for maintaining and increasing the natural supply of oysters, additional experiments were conducted at the shellfish laboratory at Milford, Conn., relative to the life history, habits, environment, culture, and artificial propagation of the oyster. Milford Harbor is typical of the numerous coves, bays, and estuaries that are the natural habitat of the oyster, and in former times shellfish were very prolific there, so that scientific data derived from detailed study of the oysters present in this small body of water can be used as the basis for developing oyster culture in other localities.

To rehabilitate this small harbor, the Connecticut Oyster farms Co. supplied oysters enough to establish two fair-sized spawning beds, one of which was located on the tidal flats and the other in the channel. As these waters are at present unpolluted to any serious degree it is possible to study the oyster under conditions similar to those under which it thrived in years past.

A brief résumé of the various studies and experiments made and the results obtained follows.

Spat collection.—The tidal flats in the harbor were planted with brush, shells, and tile collectors, each of which successfully demonstrated the value of such flats for producing annual harvests of seed oysters. The birch brush, which was planted in rows and stacks over an area of about 6 acres, was covered with a good set of oysters for a distance of 2 feet above the bottom, and after the oysters had attained a good size, the brush was transplanted to the deep-water beds in the sound.

At the suggestion of Capt. Charles E. Wheeler, manager of the Connecticut Oyster Farms Co., a dozen wire baskets were filled with oyster, clam, and mussel shells and placed on the flats. These proved to be the cheapest and most practical type of collector used in the experiments. Each of the shells on the top, bottom, and sides of the baskets was covered with from 100 to 200 spat, those in the layer just inside were covered with from 12 to 50 each, and those in the very center caught from 2 to 10 spat each. Each bushel of oyster shells caught about 15,000 spat, while the baskets of clam and mussel shells caught a few thousand less than this. This method can be made even more efficient by using the large, brittle oyster shells from the Housatonic River, which make it possible for more spat to attach in the center of the baskets and which, after being transplanted to off-shore grounds, easily break up, allowing the young oyster ample room for growth.

Another type of collector used in the experiments was half-round, glazed tile, having a surface of about 1,000 square inches. The average number of spat collected by each tile from the first set of oysters

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was 1,500, and from the second, which was heavier, 4,000. After the spat had attained their summer growth, they were easily detached from the tiles without injury and planted as single seed oysters; in a few years they will have developed into "select" stock, the most valuable product produced in this fishery.

The location and arrangement of the various collectors had an effect on the time and condition of tide when and depth and vertical range at which setting takes place, and valuable data on these points were collected. Shells and rocks scattered about the harbor also were covered with spat, and from a small bar near the brush plantings over 100 bushels of gravel, heavily set with oysters, were collected.

The countless millions of seed oysters produced as a result of the incomplete restoration of this harbor evidence the value of these inshore areas to the oyster industry and the necessity of protecting them from overfishing and pollution.

Life-history studies.—Spawning records were obtained from three lots of ripe oysters, of 10 bushels each, kept under close observation in a float. In each experiment, almost all of the oysters spawned vigorously and simultaneously. Spawning occurred at 24.1°, 22°, and 23° C., when the tide approached high-water mark. Records of salinity and hydrogen-ion concentration were made at the same time. The oysters on the spawning beds in shallow and deep water became ripe much sooner than usual this year and discharged their spawn on about the 6th and 13th of July.

Plankton collections were made in Milford Harbor and Long Island Sound for the purpose of determining the abundance, distribution, and growth of the free-swimming oyster larvæ prior to setting. The collections made from 1921 to 1924 gave evidence of a strange disappearance of the larvæ from the time they were one or two days old until they were nearly ready to set. Similarly, careful pumpings and tows made in 1925, from the surface of the water to within a few inches of the bottom, contained very few oyster larvæ of the intermediate sizes. From observations of the behavior of artificially propagated larvæ of these sizes it was apparent that they were not only clamlike in structure but in habit as well, and capable of plowing their way through sand and loose dirt by means of a long, muscular foot. Several sections of bottom, about one-half inch thick, were taken up near one of the spawning beds, placed in one of the hatching tanks, and supplied with a good stream of water. After several hours, an examination of the bolting-silk net placed at the overflow revealed many of the long-sought, intermediate-sized larvæ, though it was impossible to determine whether they had been on the bottom or merely lying between the sand grains when the samples were collected. The discovery of this interesting habit enables us to understand better the relationship between spawning beds and setting areas and the effect of tides, waves, and currents on the distribution of the larvæ.

By arranging floating and stationary spat collectors from the bottom of the channel to high-water mark, the following observations on "setting" were made: First, that attachment of the greater proportion of larvæ occurred with the beginning of flood tide and continued for about two hours. Second, that the vertical distribution of the spat took place from the bottom (30 feet below the surface) to within

about 2 feet above low-water mark. Third, that the horizontal distribution in the vicinity of Milford was from the deep-water beds 2 miles offshore to areas in the harbor that are covered after the first two hours' run of the flood tide. Fourth, that the greatest concentration of spat per square inch was found in a zone 10 to 12 inches above low-water mark. Records of the rate of growth of the spat under various conditions were made from July 18 to September 20.

Environmental conditions.—Six stations located in Milford Harbor and the adjacent inshore waters of Long Island Sound were regularly visited, and observations of general hydrographic conditions were made. Water temperatures were unusually high, ranging from 20° to 25° C. on the bottom from July 15 to August 20, and attained a maximum ebb-tide temperature of 29° C. in the harbor on August 19. The salinity ranged from 25 in June to 26 and 27 during July and the first part of August, a marked increase occurring the last two weeks in August, when there was very little rainfall. The hydrogen-ion concentration was determined by the prism-comparator method using cresol red and brom-thymol blue as indicators.

Commercial oyster culture.—The best and most general set of oysters since 1914 was obtained in 1925 throughout the oyster-growing region of Connecticut with the aid of unusally favorable weather and water conditions. At the present time a set of commercial value in these waters depends upon the early ripening and spawning of the oysters on the inshore and offshore beds of Long Island Sound, as these are the only ones large enough to produce a sufficient quantity of spawn. In the past when the oyster industry succeeded in obtaining a crop of oysters almost every year, large, natural beds were situated in the harbors, bays, and river mouths, where conditions were favorable for the production of large quantities of spawn. Today almost all of these valuable spawn-producing and shellfish-growing areas have been destroyed by excessive pollution and overfishing, so that only the deep-water beds are left for the production of seed oysters.

When conditions existing on these deep-water beds in spring and summer are such as would ordinarly exist in the harbors and estuaries, oyster culture is successful, but unfortunately this happens rarely. The climatic and hydrographic records for the summer of 1925 reveal that precipitation, river discharge, air and water temperatures, and salinity were unusual and produced the desired harborlike conditions in the sound, which resulted in successful deep-water oyster culture. The State of Connecticut recently passed an act creating a State water commission with power to enforce the adoption of reasonable and practical measures for controlling, reducing, and eliminating pollution. No greater improvement could be made for maintaining and increasing the oyster supply of Connecticut than the restoration of its harbors and rivers.

CLAMS OF THE PACIFIC COAST

During 1925 the clam investigations on the Pacific coast were continued by Dr. F. W. Weymouth, of Stanford University, and H. C. McMillin, scientific assistant. Field work was carried on from April to September, during which time two months were spent on the Washington beds getting more exact spawning data and records of

the environmental conditions. Three sections were studied especially to determine the difference in physical factors and how these are reflected in growth.

The onset of spawning was observed and studied at Cordova for the first time. The water was colder than on the Washington coast when spawning began, but the same relative change in temperature appears to incite the action. Discharge of eggs begins slowly and becomes more rapid after one day, but spawning never takes place as rapidly as it does in Washington. No information has been received about the set that resulted from the 1925 spawning, but usually there are fewer young in Alaska than on the Washington beds.

When the field work was performed in 1924 it was noticed that razor clams in various localities seemed to become sexually mature at a common size rather than at a common age. In working up these data, therefore, the influence of size and age on sexual maturity was especially observed, and in addition the relation between size and age was determined for various localities.

As razor clams in Washington grow approximately twice as fast as do those in Alaska, it is of economic importance to determine whether they really become spawners in one-half the time. It was found that the older clams average a smaller size at maturity than the younger ones. Specimens from Washington matured in less than half the time required by those from Cordova, but the Cordova specimens averaged more than one-half centimeter smaller in size. Figures from all the beds showed that 1 centimeter in size was approximately equal to 10 years in age in sexual maturity.

Proportional measurements of razor clams from beds in California, Oregon. Washington, British Columbia, and Alaska indicate that the economically important forms all belong to a single species rather than to several, as asserted by some systematists.

A report was published in 1925 covering the results of the investigations made in 1923 and 1924.

SCALLOPS

Because of a sudden great reduction in the number of scallops, the Fisheries Commission Board of North Carolina requested the bureau to make an investigation, and J. S. Gutsell was assigned to the work.

The scallop fishery occupies an important place among the fishery industries of the State and is an extremely important one among those of Carteret County, to which it is confined. In recent years it has approximated in financial importance the oyster industry of the entire State, with an annual value of nearly $250,000.

A survey made by the Fisheries Commission Board during the summer of 1924 was reported to have revealed an unusually great and widespread abundance of scallops. A later survey, following unprecedentedly heavy rains, showed almost complete mortality except over unaffected areas in lower Bogue Sound. The scallop fishery confirmed these findings, revealing scallops in great abundance wherever they are found at all. Although direct evidence is lacking, there seems to be no reason to doubt that unusually low salinities resulting from abnormal rains caused the mortality.

Dredging surveys made by Mr. Gutsell and a representative of the Fisheries Commission Board revealed scallops in appreciable numbers in one small area only, a truly alarming outlook. However, by wading over suitable flats near the Beaufort laboratory scallops were found in considerable numbers in a few places. These areas had been devastated by floods the preceding season and made apparently barren, so that no satisfactory explanation for their fertility in 1925 can be given.

Small or seed scallops were very scarce early in the summer, but were obtained in moderate numbers late in the summer and became somewhat more abundant, though probably not normally so, as time passed.

Measurements of adult scallops show a fairly even and rapid growth from mid July to mid September, a lack of further growth until mid November, and thereafter moderately rapid growth, with no indication of cessation at the end of the year. This renewed growth is also clearly revealed by examination of the shells. The late fall growth was altogether unexpected. The only phenomena with which it seems reasonable to connect the nongrowing period are sexual functionings of some sort. Possibly metabolic activity is diverted from shell growth to the production of spawn.

The bay scallop is one of the shortest lived of commercial bivalves. In the north, it has been shown that in the majority of cases individuals die during or after their second winter and before spawning time the following summer—that is, before the scallops are 2 years old. Although the prolonged spawning complicates matters and data are insufficient for any positive statement as to length of life, there seems to be little doubt that there is a distinct resemblance between the later life histories of scallops in northern and southern waters.

The scallop is a hermaphroditic species. It is presumed to commence spawning some time in the spring in North Carolina. Observations made in July showed that some scallops had spawned, and spawning was observed in August and continued to the end of December. In mid December about half of the scallops contained considerable quantities of spawn and about a quarter of them had large quantities. Evidently observation over a period of at least a year is necessary for even approximate knowledge as to when spawning begins and ends.

Recommendations for the protection of the scallop beds have been made to the State Fisheries Commission Board based on the results of this investigation. Some of these have already been favorably acted upon, and it is anticipated that further action will be taken in the near future.

FRESH-WATER MUSSELS

In addition to the regular annual survey of certain mussel beds of the Mississippi River by the shell expert of the Fairport (Iowa) laboratory, J. B. Southall, a special survey of the upper Mississippi between Lake Pepin and La Crosse was conducted by Dr. N. M. Grier, of Dartmouth College. A similar survey over the same territory was made by Doctor Grier in 1920.

The rearing of mussels in hatchery troughs was continued, but this work was subordinate to the researches of Dr. M. M. Ellis, of the University of Missouri, special investigator at the Fairport laboratory during the past summer. Doctor Ellis studied the elimination of the parasitic period in the culture of fresh-water mussels and made very material headway in this direction. He also definitely determined the importance of the acid-alkali balance of the blood of the fish to the glochidia encysted in its gills. This proved to be an important factor in the cultivation of mussels without host fishes. This work will be continued.

Doctor Ellis also worked on the effect of light upon the glochidia of mussels. He determined that the unfiltered, ultraviolet rays of direct sunlight are quickly fatal to glochidia, and that if only partially filtered they may cause disturbances seriously affecting the development of the glochidia. Juvenile mussels also appear to be sensitive to ultraviolet rays, which confirms the observation made by Dr. A. D. Howard that a greater proportion of juvenile mussels survives when they are shielded from light.

TERRAPINS

The experiments in diamond-back terrapin culture, which have been conducted at the Beaufort (N. C.) biological station for a number of years, were continued with success. More information is being gained all the time relative to the requirements of the terrapins. One of the most important recent contributions, from an economic standpoint, had to do with crowding, it having been shown that many more terrapins than it was formerly thought advisable to hold can be held in an inclosure when a supply of clean water is available. Stagnant or dirty water is extremely detrimental, especially when the animals are crowded. This work is under the supervision of Dr. Samuel F. Hildebrand, and is in the immediate charge of Charles Hatsel.

The total number of terrapins removed from the egg beds during the fall of 1925 was 2,968. The total number taken from the egg beds in the fall of 1924 was 3,458. The main cause of the decrease in the number of terrapins hatched in 1925 was the decline in the number of eggs laid by the original breeders, some of which have been at the station since 1902 and others since 1906. All of these were mature when confined, and some of them, no doubt, were already very old. It remains to be seen whether the decrease is due merely to the normal yearly fluctuations that have taken place previously or whether a permanent decline (possibly due to old age) in eggs and young produced has set in.

A cooperative arrangement has been entered into with the Fisheries Commission Board of North Carolina for hatching and liberating young terrapins with the view of restocking the sadly depleted State waters. The Fisheries Commission Board has impounded 488 adult terrapins at the biological station for breeding purposes, and is supplying their food and a man to assist in feeding and otherwise taking care of the terrapins. Arrangements have been made to build another pound and to extend this work.

ECOLOGICAL AND OCEANOGRAPHIC STUDIES

CONTROL OF MOSQUITOES BY MEANS OF FISH

Investigations relative to the use of fish for controlling mosquito breeding were continued at Greenwood, Miss., in cooperation with the United States Public Health Service. This work was under the supervision of Dr. Samuel F. Hildebrand and in immediate charge of Irving L. Towers. The season was favorable until the latter part of September, when heavy and continuous rains set in and the work was abandoned for the season.

Gambusia continues to give better results than any other fish. In fact it no longer seems worth while to give consideration to any other species in connection with mosquito control in regions where Gambusia is common. In general, Gambusia provides mosquito control just to the extent that it is able to reach the larvæ. Complete control is rarely possible, but the presence of this fish always brings about a very large reduction in mosquito production.

OCEANOGRAPHY

At the request of the New York Zoological Society, two members of the bureau's scientific staff, Dr. Charles J. Fish and Marie Poland Fish, were detailed to join the *Arcturus* oceanographic expedition, the former to supervise the oceanographic work and the latter to investigate the distribution and early development of ocean fishes. The cruise lasted six months, February 14 to July 30, 1925, during which time the Gulf Stream, Sargasso Sea, North Equatorial Current, Antilles Current, Mexican Current, and the Galapagos and Cocos Island regions were investigated. In all 113 stations were made and numerous collections of plankton and many physical and chemical data were secured. Any conclusions drawn at this time must necessarily be of a very general nature and subject to modification or change when the data have been studied more carefully.

The *Arcturus* entered the Pacific during a recurrance of the dreaded El Niño, a warm, counter water mass from the north, which about once in 20 years penetrates along the South American coast as far as Peru, carrying tropical fishes and other marine forms far beyond their usual range in this area and causing enormous destruction to the life of the cold Humboldt Current as well as to the guano birds, which rely upon pelagic marine organisms for food. The loss to Peru in guano alone at such times is tremendous and forms a problem of national importance. Temperature sections taken by the *Arcturus* in this region indicate that El Niño does not in reality divert the Humboldt Current from its course, as is popularly believed, but flows over it as a comparatively thin film. Everywhere in the Galapagos region Humboldt temperatures were encountered below 100 meters. It is therefore highly improbable that a warm and consequently lighter current of temporary nature pushed aside the permanent cold and heavier Humboldt Current by wedging between it and the coast, particularly as previous records show the latter body of water to be of a slightly higher salinity.

The vertical distribution of life in the ocean formed one of Doctor Fish's most important problems. Everywhere the same zones could

be distinguished but were found to vary somewhat in the position of their upper and lower boundaries as well as in the richness of the distinct animal communities characterizing them. Temperature, light, and pressure appear to be the most important physical limiting factors. As all life in the lower levels ultimately depends for food upon organisms that descend from the surface waters, collections from even the deeper zones in such areas as the Gulf Stream and about the Galapagos Islands, where an abundance of surface life exists, were exceedingly rich. Conversely, in barren areas like the Sargasso Sea, where the surface fauna is scanty, the intermediate levels are very sparsely inhabited; in fact, so scarce was the animal life that it was at times impossible to determine faunal limits. Although poor in species, the zone yielding the largest hauls was situated just below the depth to which surface animals descend in the daytime. This hitherto unrecognized zone, between 400 and 700 meters, is now named the "transition zone," as it comprises the zone of transition from daylight to darkness. It adjoins the lower part of the "silver zone," recently used in classifying the vertical distribution of fishes lying within the limits of 150 to 500 meters. Below 2,000 meters and above the bottom community, there appears to be a region (recorded first by the United States fisheries steamer *Albatross*) visited only by scattering forms or falling dead bodies. Although this theory has at times been attacked, the *Arcturus* collections substantiate in every respect the observations of Mr. Agassiz for those particular regions traversed.

Enormous schools of tuna observed between Mariato Point and Cocos Island from May 11 to June 3 were apparently making their annual migration. A brief report on them has been submitted to the bureau.

Progress has been made in working up the data collected during the hydrographic and biological survey of Chesapeake Bay, and it is anticipated that the final report will be completed within a comparatively short time.

The study of the currents, temperatures, etc., in Massachusetts Bay has already been mentioned in the discussion of the investigations of the early life of the cod, pollock, and haddock. A report on certain phases of this investigation was prepared and submitted by Richard Parmenter, temporary assistant.

The comprehensive investigation of the oceanography of the Gulf of Maine, which has been conducted for a number of years by Dr. H. B. Bigelow, of the Museum of Comparative Zoology, Harvard University, is nearly completed. The section dealing with the fishes has been published already, that dealing with the plankton is in the hands of the printer, and the section dealing with the physical oceanography is in an advanced stage of preparation.

In cooperation with the Bureau of Lighthouses, water temperatures have been taken at a number of selected stations along the Atlantic coast.

ECOLOGY OF FRESH-WATER LAKES

During the summer of 1925 limnological observations were made on some 50 lakes in northern Wisconsin by Dr. Chancey Juday of the State Geological and Natural History Survey. Most of these lakes are situated in Vilas County and range in area from 3 to 1,500

acres and in maximum depth from 2 to 35 meters. During the summer of 1925 the surface temperature was as low as 19° C. in some of these lakes and as high as 24° C. in others.

These bodies of water may be regarded as having soft water, as they have only a relatively small amount of calcium and magnesium in solution. Several, which have neither an inlet nor an outlet, contain less than 2 cubic centimeters of fixed carbon dioxide per liter; most of them have between 5 and 12 cubic centimeters per liter.

The epilimnion, or upper stratum of water, in these lakes was well supplied with dissolved oxygen, the amount ranging from 5 to 7 cubic centimeters per liter of water. In some of the deeper ones the the hypolimnion, or low water, possessed very little or no dissolved oxygen at all in late July and in August.

In the lakes having a depth of 5 meters or more the lower water generally yielded a larger amount of free ammonia than the upper stratum; the reverse was true of some of the lakes that possessed a relatively small amount of plankton. The quantity of free ammonia found in the upper water of the various lakes varied from a minimum of 0.024 to a maximum of 0.148 part per million; this represents a sixfold difference. In the lower water the quantity of free ammonia ranged from a minimum of 0.020 to a maximum of 0.968 part per million.

The theory has recently been advanced that the quantity of phytoplankton produced by a body of water is dependent upon the amount of phosphorus that is available in the water. In order to see whether such a correlation could be established for these lakes, a quantitative study of the phosphorus was made, but the data obtained in 1925 do not warrant any definite conclusions. It was found that the quantity of phosphorus in the upper water ranged from none at all to a maximum of 0.095 milligram per liter of water. No phosphorus was obtained in the lower water of one small lake that is only 7 meters deep, but the lower water of all of the other lakes yielded a measurable amount of phosphorus. The quantity varied between 0.005 and 0.09 milligram per liter in most of the lakes. A maximum of 5 milligrams per liter was noted in a lakelet only 122 meters (400 feet) in diameter, but which is 22 meters (72 feet) deep.

The lowest readings for hydrogen-ion concentration were obtained in 11 lakes that have less than 2 cubic centimeters of fixed carbon dioxide per liter of water; in this group the reaction ranged from pH 6.9 at the surface to pH 5.4 at the bottom. It will be noted that all of these readings were on the acid side. In the lakes that had more than 2 cubic centimeters of fixed carbon dioxide per liter of water the surface water was neutral or alkaline (pH 7.1 to 9.4), while the bottom water of some of them was acid and of others neutral or alkaline (p H 6.4 to 7.6).

The total plankton varied from a minimum of 545 to a maximum of 6,990 milligrams of dry organic matter per cubic meter of water. In general, the shallower lakes yielded a larger amount of plankton per cubic meter of water than the deeper ones. The maximum was obtained from the surface water of a lake having a maximum depth of only 8 meters.

A few quantitative observations were made on the larger bottom-dwelling animals, but only a very limited amount of time could be spent on to this phase of the general investigation. An interesting

observation may be noted in this connection—it was found that *Mysis relicta* leaves the bottom of Trout Lake at night and migrates to the surface.

FOULING OF SHIPS' BOTTOMS

The investigation of the fouling of ships' bottoms was continued during 1925 both at New York and at Beaufort, N. C. This work involved the examination of about 50 ships in dry dock and considerable experimental work at the Beaufort laboratory, and finally a complete report covering all of the work has been submitted.

On the basis of careful examination of 250 ships at the time of dry-docking, it has been ascertained that fouling is caused by both plant and animal growths, the latter being the more important wherever fouling was at all extensive. These were barnacles, hydroids, algæ, tunicates, bryozoa, mollusks, and protozoa, in the order of frequency and usual abundance.

It was soon noted that fouling organisms were almost exclusively those forms commonly found on rocks near shore, especially in harbors, and it was found, furthermore, that fouling occurs almost entirely while vessels are in port. Most ships were found to be moderately fouled after 6 or 8 months from the date of previous dry-docking, and it was shown that the time that elapses between dry-dockings is of significance, for fouling increases with the interval of time. However, fouling was least on ships that spent most of their time cruising at sea.

The data regarding relation of light to the amount and kind of fouling, a relationship early noted on ships' bottoms, have been supplemented by extensive experiments that demonstrate that light in the field of green and blue-green has the maximum stimulating efficiency for the cyprid larvæ of several barnacles, and that at the time of attachment these forms are negative to light.

The relation of fouling to fresh water was also studied experimentally, and it was demonstrated that fresh water kills, within 72 hours, most of the organisms that cause fouling; but if calcareous growths have already formed, such materials remain, and the resistance to the movement of the ship is not materially reduced.

A preliminary study of seasonal periodicity indicates that the amount of fouling on a given ship can be predicted from a knowledge of seasonal periodicity for the organisms in the ports visited. Indications of a selective process of attachment by barnacles have been noted, indicating a relation between attachment and the nature of the surface.

INVESTIGATIONS PERTAINING TO FISH-CULTURAL OPERATIONS

PHYSIOLOGY AND NUTRITION OF FISHES

Feeding experiments with fingerling trout were carried on during the summer of 1925 at the Holden (Vt.) hatchery by M. C. James, under the supervision of Dr. H. S. Davis. As previous experiments at Manchester, Iowa, and White Sulphur Springs, W. Va., with rainbow-trout fingerlings gave such encouraging results, it was decided to conduct similar experiments at a brook-trout station. For this purpose, brook-trout fingerlings were divided into lots of 1,000 each

and were fed on a diet of sheep liver and beef heart to which 1.5 per cent of cod-liver oil and 2 per cent of dried brewer's yeast had been added. The results of this experiment showed that with brook trout no practical benefit is derived from the addition of cod-liver oil and yeast, either individually or in combination. In some cases apparently an increased growth followed the addition of these accessories, but as mortality also increased in such cases it is probable a selective action may have been in effect. It is logical to assume that the survivors were the larger, more vigorous fish, which would account for the higher average individual weight.

These results are in striking contrast with those obtained during the previous two seasons with rainbow fingerlings, where the beneficial results from the addition of oil and yeast were clear and unmistakable. The explanation of such diverse results with the two species of trout is not obvious, and furthur investigations are necessary before the matter can be cleared up. However, there is some evidence that in the case of the rainbow trout the beneficial effects of the cod-liver oil may be associated with an obscure disease that is prevalent among the rainbow fingerlings at the hatcheries where these experiments were conducted. This disease is characterized by the accumulation of crystals and casts in the kidney tubules. The water at these hatcheries is rich in calcium and magnesium bicarbonates, and it is not impossible that the disease is the result of impaired calcium metabolism, in which event the reason for the beneficial effect of cod-liver oil is apparent. For some unknown reason brook trout do not appear to be as susceptible to this disease as the rainbows. The lack of similar results from the addition of yeast to the diet of the brook trout may be due to the fact that in many cases the yeast was found to develop, for a short time at least, in the intestines of the fish. No such growth has been observed in the rainbows.

The reason for the failure of the experiment was not as clear in the case of oil as with the yeast, and further experiments with oil are planned for the coming season. The results of some experiments conducted for the bureau at the Connecticut State hatchery at Burlington, Conn., in which 1.5 per cent of cod-liver oil was added to beef liver fed to brook-trout fingerlings, indicate that the addition of the oil was beneficial.

As in previous experiments, beef heart was found to be a more desirable diet for young fingerlings than sheep liver, both as regards mortality and rate of growth. As the fish grow older, the advantages of the heart diet become less, and after two or three months the liver-fed fish may reach a larger size than those kept on a heart diet.

For the purpose of testing the effects of stale food on fingerling trout, 2,000 brook-trout fingerlings were divided into two lots of 1,000 each. One lot was fed "fresh" liver, the other "stale" liver that had been kept in the ice box for a week or more. This liver was noticeably stale or sour but had not begun to putrefy. From the very beginning of the experiment, which was continued from July 9 to August 11, the fish fed "stale" liver showed a much higher mortality and slower growth than the controls, which were fed fresh liver. The total mortality in the former lot was 41.2 per cent, and the average individual weight increased from 0.412 grams to 0.722 grams.

In striking contrast with this, there was a total mortality of 16.7 per cent and an increase in the average individual weight from 0.445 to 1.135 grams in the control lot.

The feeding experiment at the Wytheville (Va.) station, mentioned in the previous report, was discontinued on April 29, 1925. In this experiment rainbow-trout fingerlings were divided into two lots of 2,000 each. One lot (the controls) was fed a straight heart diet, while small quantities of cod-liver oil and dried brewer's yeast were added to the beef heart fed to the other lot. Throughout the experiment there was a marked contrast in the mortality of the two lots. The total mortality from May 29, 1924, to April 29, 1925, in the lot fed a diet containing oil and yeast was 44.1 per cent; while in the control lot, which received only beef heart, the loss was 82.8 per cent. The high mortality in both lots was, no doubt, due in part to the fact that the fish were kept in ordinary hatchery troughs throughout the course of the experiment and, in the case of the vitamin-fed lot, became badly crowded before the experiment was terminated. Yet, in spite of this fact, the mortality in this lot was much lower than among the controls up to the very end of the experiment. This experiment is especially significant because it was conducted under ordinary hatchery conditions and continued for a much longer time than any other of the feeding experiments.

HOLDEN EXPERIMENT STATION

During the past year arrangements were made to utilize the Holden, Vt., substation for experimental work in cooperation with the division of fish culture. Such an experimental station is badly needed, as it will provide an opportunity to investigate various problems connected with the artificial propagation of trout and other fishes, for which purpose the Holden station is well adapted. The hatchery is supplied with both brook and spring water, which can be mixed in any proportion required. There is also ample room for the construction of ponds of various types, which will be of great value in experimental work.

Experiments were begun at the station during the spring of 1925, but owing to lack of equipment it was possible to hold only a small number of trout through the summer. For this and other reasons the work during the summer was of a purely preliminary character. Several ponds were constructed and others will be added as soon as funds are available. A small laboratory has been fitted up at the station, and with the increased facilities available it will be possible during the coming season to carry on extensive investigations in the nutrition and diseases of trout. It is also planned to conduct systematic experiments in selective breeding in the hope that it will be possible to produce a more vigorous and hardier race of brook trout better adapted to hatchery requirements.

In addition to the work at the station, a series of field investigations is contemplated primarily for the purpose of obtaining more definite information regarding the results of artificial propagation and the possibility of increasing its efficiency. There are numerous native trout streams in the vicinity of the station, which will afford an excellent opportunity for investigations of this nature.

PATHOLOGY

As noted in the last report, the bureau, at the request of the Eastern Trout Growers Association, undertook an investigation of the so-called "soft-egg" disease, which during the last few years has caused serious losses among brook-trout eggs at a number of commercial hatcheries in New England. Owing to the short time during which the disease is prevalent, it was impossible to complete the investigation during the season of 1924. However, it was found that the trouble is due to an external parasite, possibly an ameba, which forms small holes in the egg membrane. A continuation of the investigation was planned for the spawning season of 1925, and for that purpose M. C. James visited some of the hatcheries, but no trace of the disease could be found. With one exception, all the hatcheries reported an entire absence of the disease throughout the season. In the case of the single exception noted, a slight outbreak occurred in one trough late in the season but was quickly brought under control.

The absence of the disease during the spawning season of 1925 from hatcheries in which formerly it was prevalent can only be ascribed to the use of thoroughly sanitary measures, which were adopted on the bureau's recommendation when the disease was found to be due to an external parasite rather than to some obscure cause such as improper food.

At the request of the Connecticut State Board of Fisheries and Game, Dr. H. S. Davis made an investigation of an outbreak of a little-known fin disease at the State hatchery at Burlington, Conn. This disease apparently has been prevalent for several years at the Windsor Locks hatchery, where it has caused serious mortality, and evidently was introduced into the Burlington hatchery with fish transferred from Windsor Locks. The disease causes the fins to become badly frayed, the dorsal and caudal fins being affected most seriously.

Owing to the pressure of other work, it was impossible to devote sufficient time to the disease to arrive at any definite conclusion as to its cause. However, the experience of the hatchery staff indicates that the disease can be controlled by the use of a dilute solution of potassium permanganate followed by strong salt baths at frequent intervals.

POLLUTION

At the request of the Louisiana State Conservation Commission, Dr. H. S. Davis made an investigation of pollution in the Dorcheat Bayou from the surrounding oil fields, of which there are several. Numerous complaints had been received by the commission that pollution from the oil wells had resulted in serious mortality of fish in the bayou. It was found that under ordinary conditions pollution from the oil fields was sufficiently dilute so as not to affect the fish in the bayou seriously, although practically all life was destroyed in small tributary streams that drained the oil fields. However, during periods of exceptionally low water, which occasionally occur, many fish are killed below the point where the pollution enters the bayou.

Further attempts were made to cultivate of the shovel-nose sturgeon (*Scaphirhynchus platyrhynchus*) and paddlefish (*Polyodon spathula*) at the Fairport (Iowa) laboratory, without results. The culture of channel catfish, buffalofish (*Ictiobus bubalus*), bluegill sunfish, crappie, and largemouth bass was conducted at this station on a large scale. Effort was made to fully develop the fish-cultural possibilities of the station in the belief that this would be of benefit in promoting the further development of present pond-cultural methods. The surplus fish were distributed to applicants.

One small pond was again devoted to the rearing of sheepshead (*Aplodinotus grunniens*), this time with success. While at present this fish is popular only in small sections of the country, the fact that it has good food qualities and thrives well in certain waters was believed to warrant a study of its pond-cultural possibilities.

INSPECTION OF THE SPONGE FISHERIES

The inspection of the sponge fishery centering at Tarpon Springs, Fla., was conducted as usual by Walter Topliff, inspector of sponge fisheries. A total of 547 vessels was inspected, 212 at sea, 256 at Tarpon Springs, and 79 at Cedar Key. In addition, the inspector made regular examinations of the catch while it was being sorted, arranged on strings, and sold at the sponge exchange at Tarpon Springs.

The value of the sponges taken from the Gulf of Mexico along the coast of Florida remains almost constant, although the number of bunches fluctuates from year to year, largely due to the unstable demand for the cheaper grades. However, there apparently is a slight downward trend in the production and a noticeable decrease in the number of sponges of the larger sizes. These are undoubtedly evidences of the depletion of the fishing grounds, which have been intensively exploited for many years. It is stated that no new grounds have been exploited in the past 10 years although a few trips have been made to the westward of Cape San Blas, but with such poor results that they were not repeated. Sponge beds of considerable extent exist in the deeper waters in the vicinity of Key West, which are lying dormant due to the inability of the Key West spongers, who use only hooks and poles, and the Greek divers of the northern field to agree on working conditions. If the Key West field could be made available to the divers, it would help to relieve the too great intensity of fishing that exists at present in the Tarpon Springs field.

BIOLOGICAL LABORATORIES

During the summer of 1925 the laboratory at Woods Hole, Mass., was used more extensively than for many years. Its capacity, as well as that of the residence building, was taxed to the utmost to accommodate over 40 independent investigators and assistants. The increasing demand for these accommodations makes it imperative that the bureau change its policy with regard to the privileges of this laboratory. In the past very little selection was exercised because quarters were available for all applicants, but under present conditions

it is believed that the best interests of the bureau will be served if accommodations are accorded only to those who are working on problems of special interest to the bureau (especially problems in marine biology) and who have shown a capacity for energetic and productive research.

Some of the more important researches conducted at the Woods Hole laboratory during the summer of 1925 were as follows: Studies on the comparative composition of fish blood and the changes that take place during asphyxiation were continued by Dr. F. G. Hall, Dr. Lepkovsky, and Irving E. Gray. Dr. N. A. Cobb, of the Department of Agriculture, with several assistants, continued a study of the nematode fauna of the Woods Hole region. Dr. Edwin Linton and Dr. G. A. MacCallum carried on their studies of fish parasites, as they have done for many years past. Paul S. Conger, of the Carnegie Institution of Washington, working under the direction of Dr. Albert Mann, continued the study of the diatom flora, with particular attention to the bottom forms. Dr. C. B. Wilson carried on important studies in both parasitic and free-living copepods and among other things completed the examination of a large number of collections made by the *Albatross* and other research vessels of the bureau. Although these collections were old, they were well preserved and proved to be extraordinarily rich in new species. O. E. Sette, assistant in charge of the division of fishery industries, made use of the facilities of the laboratory in beginning an important investigation of the mackerel fishery. Dr. C. J. Fish and Marie Poland Fish returned from the *Arcturus* expedition in July and, with headquarters at Woods Hole, continued their studies of the plankton and larval fishes of Massachusetts Bay, which have been mentioned above. Dr. P. S. Galtsoff carried on important investigations on the feeding of oysters, as described in the section devoted to the oyster researches.

Work at the Beaufort (N. C.) biological laboratory has materially increased. Dr. Samuel F. Hildebrand, who was appointed director early in the year, took active charge of the station toward the end of June. James S. Gutsell was assigned to this laboratory in July and has undertaken an investigation (mentioned elsewhere in this report) of the scallop industry in Carteret County, N. C. Elmer Higgins, director of the Key West biological station, spent almost the entire year at the Beaufort station studying the life history of the striped mullet and other important food fishes. Dr. J. Paul Visscher and Robert Luce, who were engaged in a study of the prevention of the fouling of ships' bottoms for the Navy Department, made use of the laboratory during the summer. Seven independent investigators also availed themselves of the privileges of the station.

Prof. H. V. Wilson, of the University of North Carolina, made a survey of the local distribution of sponges and some other forms, as affected by recent changes in the harbor. It is found that a number of species are now missing where previously they were common or even abundant. Doctor Wilson believed that the increased activities in the harbor, particularly the dredging, and certainly, also, the heavy rains during the autumn of 1924, are responsible for the changes.

Dr. R. E. Coker, of the University of North Carolina, collected free-living copepods and identified the more common species. The material collected was retained by Doctor Coker for further study.

Dr. Bartgis McGlone, of the University of Pennsylvania, studied the effect of varying the hydrogen-ion concentration of sea water upon fertilization and rate of segmentation of the eggs of echinoderms. The results of this work could not be reported when Doctor McGlone left the station, because the necessary microscopical work in determining the results had not been completed.

Dr. W. C. George, of the University of North Carolina, spent a short time at the station making a histological study of the blood cells of certain species of ascidians.

W. R. Earle, graduate student of the University of North Carolina, studied and collected material bearing upon the regenerative processes in several forms of hydroids, and he also collected and preserved some material on the early embryological stages of Fundulus and the toadfish.

J. T. Penny, instructor in histology, Medical School, University of Tennessee, spent a very brief period at the station collecting and fixing specimens of Blanoglossus for study.

Miss Lorna W. Thigpen, graduate student of the University of Maine, spent several weeks at the station in a general study of invertebrate forms, principally with the view of familiarizing herself with the local fauna.

The Fairport (Iowa) biological laboratory has been mentioned in these pages in connection with the work with fresh-water mussels and in fish culture. T. K. Chamberlain is director. The fish-cultural investigations have been under the immediate direction of H. O. Hesen, superintendent, and H. C. Minch, foreman. As has been stated, Dr. M. M. Ellis, of the University of Missouri, and Dr. N. M. Grier, of Dartmouth College, were employed during the past summer in the mussel investigations. The regular staff was especially active in cooperating with various State and private organizations concerned with the conservation of aquatic resources.

Conditions at the Key West (Fla.) laboratory did not change during the year. The lack of adequate laboratory facilities made it impossible to conduct researches at this station, and the activities of the small resident staff were mainly directed toward the maintenance of the grounds and buildings.

During the year a new fisheries laboratory was established at Seattle, Wash., in temporary quarters kindly provided by the College of Fisheries of the University of Washington. The laboratory was opened under the direction of Dr. W. H. Rich and will be used as a center for the investigation of the fish and fisheries of the Pacific coast. During November and December certain of the salmon investigations were carried on here by Doctor Rich and H. B. Holmes, and it is planned to transfer the investigations on herring and clams to this laboratory in the near future. Such a laboratory has been needed for some time, and its establishment will do much to further the scientific work of the bureau on the Pacific coast.

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FISHERIES OF SIBERIA

By Boris Baievsky

Russian Expert, European Division, Bureau of Foreign and Domestic Commerce

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INTRODUCTION

Available material on the fishery industries of Siberia is fragmentary, conditional, and far from being complete. However, it is hoped that the present report will provide an index as to the relative importance of these industries and supply a better basis for forming an opinion when the subject of the fish supplies of Siberian waters is discussed. Conversion of Russian rubles has been made at 2 rubles to the dollar, while poods have been converted into pounds.

This report is one of a series of monographs on the subject "Siberia: Resources and Possibilities." The purpose of this series is to place before the American public reference material containing the most up-to-date information available. Other reports covering climate, soil, population, agriculture, fur-bearing animals, minerals and metals, transportation, trade, and industry, all prepared by the author of this paper, will either be published by the Department of Commerce or made available for examination by interested persons. The section relating to zinc resources was published in the January, 1926, issue of the magazine of the American Zinc Institute.

A brief recapitulation of this series of studies, each of which covers a special subject worked out in sufficient detail to meet the requirements of business men interested in a particular line, will be released shortly as No. 36 of the Trade Promotion Series. The sections on "Iron and Alloy Metals" and "Forest Resources of Siberia," have been issued as Trade Information Bulletins Nos. 359 and 378, respectively, of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

[1] Appendix II to the Report of the U. S. Commissioner of Fisheries for 1926. B. F. Doc. 1006.

FISHERIES

Fishing is carried on throughout Siberia. This industry developed mainly on the northern and northeastern coasts, where grain raising is impossible. In the agricultural districts fishing is of secondary importance, conducted mainly to supply the local demand for fish.

The fishing regions are located in places where the population is scarce and the people ignorant. During the fishing seasons the number of the native population is swelled by outside fishermen, whose only aim is to catch as much fish as possible. This leads to destructive methods of fishing, because it makes no provision whatsoever for a future fish supply. The result has been an appreciable decline in the number of fish recently caught.

A few years before the World War the number of fishermen was on the increase. The catch of fish also increased, but this state of affairs only accelerated the process of exhausting the fishing grounds in spite of Government measures directed toward the preservation of fish supplies. The Government introduced stricter fishing regulations, forbidding fishing altogether in certain waters, established hatcheries, and also compelled the fishermen to maintain hatcheries. Fish are caught by nets, by a special kind of hedge made of poles with a trap arrangement ("zayesdka"), built across rivers, and by hooks suspended from stationary lines. These methods are wasteful, as many young fish are caught that never are returned to the waters and therefore perish, while the hooks often wound fish, which also perish.

The preparation of Siberian fish was very primitive. They were carelessly cleaned, not well salted, packed in dirty barrels, and therefore constituted a product of inferior quality. When modern methods were used, the quality was equal to the best product of any other country.

The canning industry was very little developed, virtually the only fish utilized being the salmon. Ninety per cent of the canning industry was in the hands of Japanese. The canning plants, which were maintained in accordance with American standards and their output shipped to England, were mostly located in the Kamchatka Peninsula. The fish refuse was used for the preparation of fertilizer. In 1913 the total output of canned salmon was 6,600,000 pounds, of which plants in Nikolayevsk-on-Amur produced 100,000 pounds. In 1920 the pack of the principal Japanese firms amounted to 28,800,000 pounds, and of the Russian firms 9,600,000 pounds.

Russian fishermen were handicapped by lack of harbors, inadequate and expensive transportation, lack of capital and financing facilities, lack of labor, especially of experienced workmen, lack of good salt, and lack of proper marketing facilities and methods. These difficulties were aggravated by the method of leasing the fishing grounds. These grounds, with very few exceptions, belonged to the State, and new fishing stations were leased for a short period only—from one to three years. Thus it was only after a long period of time that any idea could be gained as to the productiveness of a given station, and therefore as to its value, when leased for a longer period. This made the fishing industry a very speculative affair. Fishermen had no inducement to make an investment for short periods. In a poor year, when the run of fish was small, the

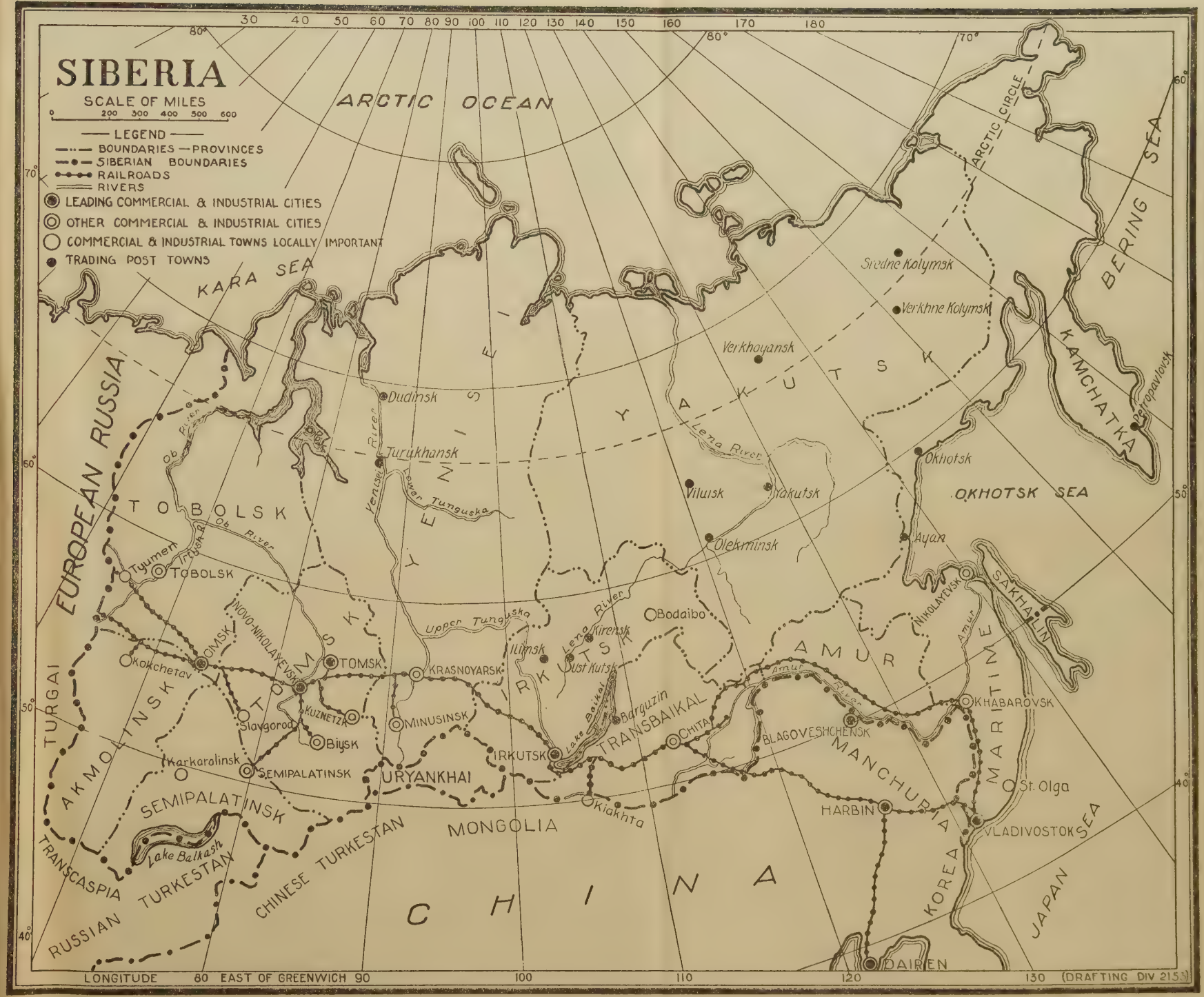

FIG. 1.—Administrative divisions of Siberia; railroads, rivers, and most important towns

102805°—26. (Face p. 38.)

fisherman had to stand heavy losses, including a large portion of his unused supplies if his lease expired. When the run of fish exceeded his estimate, and consequently his supplies, the fisherman was unable to take advantage and lost opportunity for larger profits.

Commercial fishing in the most important Siberian fishing district—namely, in the far eastern waters—was largely in the hands of Japanese, who had the advantages of near-by markets, cheap labor, excellent shipping facilities, and cheap freight rates.

How profitable the fishing industry may be in Siberian waters is shown by a conservative estimate made in 1922 by a competent business man for a fishing station in Kamchatka. This enterprise would call for an outlay of $30,000 and probably would yield a net profit of $32,000 in a period of six to seven months. Enterprises on a larger scale, with larger plants and more invested capital, may bring still larger profits, owing to better equipment, the establishment of a temporary cannery, etc.

Reduction in the world's supply of fish makes it imperative that the fishing industry be more strictly regulated, existing supplies protected, more modern methods of preparing fish and fishery products introduced, and scientific methods of breeding valuable species applied. The enormous decrease of livestock in Russia reduced the Russian meat supply. This situation can not be remedied within a short time, and therefore there will be greater demands for fish and fishery products. This further emphasizes the importance which the Siberian fishing industry is bound to attain in the near future.

SPECIES OF FISH

The principal groups of Siberian fish having commercial value are (*a*) fish ascending rivers (salmons); (*b*) marine forms (herring and cod, as well as oysters, crabs, shrimp, sea cucumbers, and kelp); and (*c*) fresh-water fish. The hunting for fur seals and sea beaver is also of some commercial importance.

The most important species are the whitefishes (Coregoni) in the Arctic Ocean and the salmons (Oncorhynchi) in the Pacific Ocean. Among the latter are distinguished the following: (1) "Keta," dog or chum salmon (*O. keta*), which is the most common species. It is of high quality and value, being superior to the American dog salmon, and weighs 9 pounds or more. Its caviar of pale red color, which was formerly regarded as waste, now finds a ready market. (2) "Gorbuscha," humpback or pink salmon (*O. gorbuscha*), which ascends all rivers of the Russian far east. It weighs from 4 to 8 pounds. (3) Red salmon or sockeye (*O. nerka*), which weighs about 8 pounds and salts very easily. (4) "Chavycha" or king salmon (*O. tschawytscha*), which weighs from 15 to 20 pounds. It has a good flavor and supplies the best caviar. This species is found only in waters of the Kamchatka Peninsula and is more abundant in Bolshaya and Kamchatka Rivers and in the rivers emptying into Avacha Bay. (The king salmon is held to be too fat for canning, but is very palatable and is considered a great delicacy when salted or smoked.) (5) "Kizhuch" or silver salmon (*O. kisutch*), which weighs about 4 to 5 pounds; and (6) "goltzi" (*Salmo malma* or *S. alpinus*), a kind of sea trout. The catch of these species in Russian far eastern waters by number, weight, and per cent is shown in the returns for the period 1909–1922. on pages 45 and 46.

Herring are very numerous in all waters of the Russian far east, but they are of commercial importance only in the Gulf of Peter the Great, the Tartar Gulf, and the west coast of Sakhalin. The average weight of this herring is about half a pound. It has been exported to Japan (as food and fertilizer), Korea, and China. Russia, which consumes a large quantity of herring, is a ready market for the product. On the eastern coast of Kamchatka Peninsula herring schools are so closely packed that it is said they can be dug out with a spade. These schools then move to the Okhotsk Sea, where they sometimes block certain streams, as, for example, the mouth of the Kukhtui River. The quality of Kamchatka herring seems to be very high. Experiments have shown that an excellent product, hardly inferior to the best European brand, can be prepared from it.

Cod are also numerous in Russian far eastern waters, but the natives ignore the fish. Only Japanese and Americans are engaged in catching cod, principally for Japansee and Chinese markets. Shoals of cod, when breeding, sometimes reach a length of over a mile, with a depth of several feet.

Fresh-water species are carp, pike, eelpout, grayling, trout, and bream.

Crabs are of large size and palatable. They are caught principally on the southern portion of the eastern Siberian coastline, namely, in America, Vostok, Ussuri, and Amur Bays. Crabs are sold fresh, dried, and canned. In 1921 there was erected near Povorotni Peninsula a crab-canning plant, which packed 1,500 cases from the season's catch. Another plant, erected in the same year on the River Svetlaya, south of Imperial Bay, also turned out several thousands of cases. China, Manchuria, and Korea are large consumers of dried crab meat.

Shrimp are found in large quantities in the southern waters of the Russian far east, and the meat has a good flavor.

Oysters are also of large size and numerous. The best oysters come from De Kastri Bay. China, Japan, and Korea are good markets for the product.

Sea cucumbers or trepangs (*Holothuria edulis*) are common along the entire Russian Pacific coast, especially in Peter the Great Bay. The dry weight is about 6 pounds.

Sea kelp is a brown seaweed with leaves about 22 feet long and 1½ inches wide, which usually grows near the shore on rocky bottoms. This weed is found along the coast of the Japan Sea and Sakhalin Island. There is a great demand for it in China.

Fur seals and sea otters are caught on the Commander Islands (near the middle part of the eastern shore of Kamchatka). These animals congregate on these islands in summer, but their number has greatly decreased, due to excessive killing by hunters. In 1890 on these islands 53,224 seals (*Callorhinus ursinus*) were killed, and in 1911 only 206 skins were taken. The number of sea otters (*Latax lutris*) killed also fell from between 200 and 250 in 1900 to 46 in 1911. The killing of fur seals in the open sea was prohibited for a period of 15 years by the fur seal treaty of 1911. This was an international measure, taken in order to increase the number of these valuable animals.

Whale, cachalots (spermaceti whale), walruses, and seals, which are found mostly in the waters of the Russian northeast, are also of some commercial value. The average value of their annual catch is estimated at $560,000.

PRODUCTION

Statistics regarding the catch of fish in Siberian waters are very incomplete and do not include either the fish caught by the population for its own consumption or for the feeding of dogs. It is estimated that 15,000,000 pieces of salmon are prepared as food for dogs annually in the Kamchatka Peninsula alone. Large fishery enterprises have been concentrated on the Pacific coast, principally in the Kamchatka Peninsula and Nikolayevsk-on-Amur districts, but it is only for fisheries of the Russian far east that there are statistical data for consecutive years. These statistics are based on returns supplied by the fishermen, and therefore they may safely be assumed to be below the actual catch, as the amount of rent for a fishing station was based on the quantity of fish caught at a given station.

Fishing in Siberian waters on a commercial basis began some 30 years before the World War. In 1911 [2] there were 26,200 fishermen including 10,000 Japanese workmen, engaged in the fisheries. The total catch of fish reached 224,000,000 pounds, valued at about $4,000,000. In the Russian far eastern waters alone 18,000 persons were employed, and there were caught about 168,000,000 pounds of fish, valued at $2,100,000. Just before the World War the catch of fish in Siberian waters amounted to 297,920,000 pounds, valued at $10,900,000. In 1913 in Russian far eastern waters 77,000,000 salmon and 41,000,000 herring were caught, from which 291,200,000 pounds of fish and fishery products were prepared. Other species furnished some 8,960,000 pounds more. Of this fish, 206,080,000 pounds, valued at $3,460,000, were exported to Japan. This shipment was made up almost entirely of salmon supplied largely by Kamchatka fishing stations.

In 1914 the total catch on the Russian Pacific coast was 304,640,000 pounds, valued at $5,000,000.

According to Japanese statistics, the Japanese caught 232,960,000 pounds of fish in 1913 in Russian far eastern waters, 136,640,000 pounds in 1915, 159,040,000 pounds in 1916, 147,840,000 pounds in 1917, 136,640,000 pounds in 1918, and 168,000,000 pounds in 1920, valued at about $23,000,000 and furnishing employment to 20,000 Japanese fishermen.

The centers of the Siberian fishing industry and the average annual catch and value of all fish in years just preceding the World War were as follows:

Region	Pounds	Value
Russian far east	253, 120, 000	$9, 000, 000
Lena-Kolyma	[a] 1, 120, 000	20, 000
Lake Baikal	11, 200, 000	400, 000
Yenisei	17, 920, 000	1, 000, 000
Ob	14, 560, 000	500, 000
Baraba	279, 920, 000	10, 920, 000
Total		

[a] Another source estimates the average catch at 11,200,000 pounds.

[2] Statistical Annual of Russian Statistical Committee, Vol. II, 1913, p. 100. St. Petersburg. (In Russian.)

During the season of 1923–24 the total production of fish and fishery products in Vladivostok, Amur and its estuary, Okhotsk, western Kamchatka, and Chukotsk-Anadyr was as follows:

Item	Pounds	Value
Salmon:		
Salted by Russian method	32, 993, 707	$1, 598, 975
Salted by Japanese method	193, 336, 551	5, 506, 500
Frozen [1]	20, 171, 046	698, 250
Caviar, Russian method	2, 932, 132	933, 800
Caviar, Japanese method	4, 900, 127	542, 800
Herring:		
Salted by Russian method	3, 387, 118	234, 500
Salted by Japanese method	382, 766	15, 900
Fresh	29, 339, 375	464, 830
Miscellaneous fish, oil, and fertilizer	101, 353, 620	1, 928, 477
Miscellaneous canned fish (762,000 cases)	36, 680, 538	6, 052, 500
Total	425, 476, 980	17, 976, 532

[1] Probably salmon.

According to the data of the customshouse in Hakodate, the market value of these products from the Russian far eastern waters in 1924 that entered the Japanese market amounted to 40,137,000 yen, the cost price of which was 15,415,000 yen. Of this amount Japan consumed products valued at 21,727,000 yen. The balance was exported as follows: To England, 8,850,000 yen; to the United States, 1,500,000 yen; to China, 3,235,000 yen; and to other countries, 4,825,000 yen.

Of the total catch of fish in 1924 of 350,267,000 pounds, 278,047,000 pounds, or 79 per cent, went to Japan, and the remaining 21 per cent went to Russia and other markets.

The catch of all fish for 1922–23 was 432,055,356 pounds; in 1923–24 it was 515,166,654 pounds; but in 1924–25 it was only 268,778,285 pounds, owing to the poor run of keta and gorbuscha.[3] The values of the Japanese and Russian shares of these catches at the prices prevailing in 1913 were as follows:

	Japanese share	Russian share
1922–23	$5, 210, 500	$4, 665, 500
1923–24	6, 701, 500	5, 933, 500
1924–25	5, 832, 500	4, 093, 000

RUSSIAN FAR EASTERN WATERS

This region has a coast line of 12,000 miles along the shores of the Japan, Okhotsk, and Bering Seas. The fishing industry in this region plays a prominent rôle, though its commercial development is of recent origin. The industry supplies the needs of the local population, for a large portion of which fishing is the sole means of livelihood, and furnishes an ever-increasing amount of fish and fishery products for export.

Russian far eastern waters are renowned for their rich fauna, exceeding in quantity and quality that of the northern part of the Atlantic Ocean. One hundred and sixteen species in the northern regions of the Japan Sea have been reported, 121 species in the Okhotsk Sea, and 165 in the Bering Sea.

[3] Taken from Foreign Trade (a weekly published by the Commissariat of Trade, Moscow), 1926, No. 10 (172), pp. 10–12.

Fresh-water fish in far eastern rivers are homogeneous, excepting in the Amur River, where 72 species are known, as compared with 50 in the Danube and 43 in the Ob Rivers. The most abundant species is the carp.

Up to the end of the nineteenth century there were virtually no regulations governing the fishing industry in the Russian far east, and Japanese fishermen came to these waters in ever-increasing numbers and engaged in fishing on a large scale. In 1899, in order to encourage fishing by Russians, foreigners were prohibited from fishing in the Amur River and its firth, and Russian fishermen were not permitted to hire foreign labor. The Russian fishing industry in these waters was especially stimulated after the Russo-Japanese War, when Russian fishermen were given certain privileges in the form of reduced freight rates to Russia, easier credit facilities, etc. Shipments of fish and fishery products to European Russia and foreign markets, excluding Japan, increased rapidly, thus freeing the Russian fishermen from Japanese domination.

As a result of the Russo-Japanese War a special fisheries convention between Russia and Japan was concluded in 1907. Under the convention Japanese nationals were accorded the same fishing rights as were enjoyed by the Russians in the waters of the Russian far east, with the exception of rivers and 34 bays and gulfs, where only Russian nationals were permitted to engage in fishing. Nearness of home markets, cheap, abundant, and experienced labor, a large merchant marine affording cheap freight rates, plenty of capital and financing facilities gave the Japanese many advantages over the Russians. The latter experienced great trouble in procuring the necessary labor, owing to the scarcity of the population in this region. This labor was transient and inexperienced in fishing. The transportation facilities afforded by the Russian volunteer fleet were inadequate in tonnage, and few sailings were maintained during the fishing season, thus entailing heavy overhead expense. Lack of salt (which had to be imported from Japan, Port Said, or Germany) and inadequate banking and financing facilities contributed to the heavy handicap on Russian fishermen, and as a consequence forced them to concentrate their activities in so-called "unconventional waters," from which the Japanese were excluded and where the Russians did not face the severe Japanese competition.

CATCH

In 1910 the total catch of fish in Russian far eastern waters was estimated at about 253,000,000 pounds, of which about 67,200,000 pounds were prepared for the Russian market and about 185,920,000 pounds for Japanese markets. The numbers of the most important species caught were as follows: Salmon, 62,600,000 (44,700,000 in unconventional waters—that is, waters reserved for Russian nationals only—and 17,900,000 in conventional waters—that is, waters open for Russians and Japanese alike), and herring, 43,500,000 (10,500,000 in unconventional waters and 33,000,000 in conventional waters). In addition, species of minor importance were caught and other fishery products prepared, of which salmon caviar was the most important. The production of salmon caviar amounted to about 6,720,000 pounds, Nikolayevsk-on-Amur producing 4,704,000 pounds,

west Kamchatka 806,400 pounds, and east Kamchatka 761,600 pounds. The major portion of the catch of fish was shipped to Japan, being prepared by the Japanese method—that is, cleaned, salted, and spread in layers, each layer being salted and covered by another layer of fish. The fish prepared by this method are very salty, dry, and tough, and usually are shipped loose in holds of vessels. The cheapest kinds of fish usually are prepared by this method.

The following table gives the quantity and value of humpback salmon and the percentage of fish shipments made to Japan during the period 1907 to 1919 (Russian Economic Review, No. 2, 1922, p. 4, Shanghai):

Year	Pounds	Value	Percentage of exports of fish and fishery products from the Far East	Year	Pounds	Value	Percentage of exports of fish and fishery products from the Far East
1907	16, 128, 000	$243, 500	21	1914	121, 408, 000	$1, 749, 500	59
1908	23, 744, 000	431, 500	27	1915	127, 904, 000	1, 704, 500	71
1909	36, 736, 000	625, 000	28	1916	104, 608, 000	1, 707, 500	78
1910	22, 624, 000	317, 500	15	1917	108, 864, 000	2, 253, 500	74
1911	104, 384, 000	1, 374, 000	46	1918	109, 536, 000	3, 227, 500	63
1912	60, 928, 000	936, 500	43	1919	104, 160, 000	3, 889, 000	54
1913	67, 872, 000	1, 138, 500	41				

In 1913 the total number of salmon reported caught was 75,000,000 and herring 46,000,000. Of this number, 282,240,000 pounds of salmon and 6,720,000 pounds of herring were prepared for market. Other fish and fishery products amounted to 8,960,000 pounds.

The importance of the Japanese market to the fishing industry of the Russian far east is illustrated by the following figures of fish exports to Japan:

Year	Pounds	Value	Year	Pounds	Value
1907	76, 289, 920	$1, 421, 398	1911	237, 039, 040	$3, 614, 077
1908	91, 714, 560	1, 867, 690	1912	146, 749, 120	3, 046, 623
1909	137, 144, 000	2, 419, 442	1913	206, 684, 800	3, 460, 260
1910	160, 321, 280	2, 690, 072			

The most important item is salmon. In 1913 imports of dog salmon to Japan amounted to 86,197,440 pounds, valued at $1,898,495; of humpback salmon, 107,490,880 pounds,[4] valued at $1,138,693; and of canned fish, 4,536,000 pounds, valued at $257,947. Of these amounts the Kamchatka fisheries supplied 140,896,000 pounds, valued at $2,889,734.

In 1920 Japanese fishermen, 20,000 in number, united in a syndicate with a capital of $25,000,000, and caught 168,656,320 pounds of fish, valued at $23,000,000. The catch of herring was largely for local consumption, but part of it was exported to Korea and China. The numbers of herring exported to Korea during various years were as follows:[5]

	Number
1915	9, 600, 000
1916	8, 600, 000
1917	14, 200, 000
1918	21, 300, 000
1919	28, 400, 000

[4] This figure does not correspond to that in the first table above (67,872,000 pounds). All figures for 1913 were taken from Consul Caldwell's report on the fisheries in the Russian far east.

[5] Russian Economic Review, No. 2, 1922, Shanghai.

The waters of the Russian far east usually were subdivided into the following districts, large commercial enterprises being concentrated in Kamchatka and Nikolayevsk-on-Amur:

Southwestern.
Nikolayevsk-on-Amur.
Okhotsk.
West Kamchatka.
East Kamchatka.
Sakhalin.

The following tables give the catch of fish [6] for the whole of Russian far east for the period 1909–1922, inclusive, showing the average catch and also the relative importance (according to the weight) of the above-mentioned districts and of species in these waters:

Catch of fish in Russian far eastern waters

Year	Salmon					
	King		Keta		Humpback	
	Number	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*
1909	2, 626	24, 640	25, 726, 048	149, 029, 440	13, 748, 765	27, 834, 240
1910	400	4, 480	41, 659, 203	234, 722, 880	14, 812, 372	29, 798, 720
1911	14, 165	127, 680	30, 765, 202	173, 624, 640	47, 156, 683	94, 738, 560
1912	30, 583	275, 520	24, 287, 857	136, 971, 520	26, 617, 349	54, 199, 040
1913	35, 478	320, 320	31, 723, 776	177, 853, 760	38, 987, 170	78, 478, 400
Average	16, 650	150, 080	30, 832, 418	174, 442, 240	28, 264, 468	57, 012, 480
1914	20, 516	185, 920	19, 990, 008	110, 938, 240	73, 870, 094	149, 869, 440
1915	27, 671	248, 640	13, 780, 069	78, 122, 240	46, 045, 475	91, 568, 960
1916	23, 845	215, 040	7, 981, 144	44, 107, 840	84, 495, 417	170, 103, 360
1917	39, 324	353, 920	14, 056, 063	76, 787, 200	92, 506, 876	184, 963, 520
1918	91, 413	799, 680	15, 663, 959	86, 894, 080	75, 382, 739	152, 201, 280
Average	40, 554	360, 640	14, 298, 248	79, 369, 920	74, 460, 121	149, 744, 000
1919	51, 375	499, 520	15, 376, 650	90, 677, 440	57, 467, 538	114, 311, 680
1920	76, 807	694, 400	16, 213, 774	83, 681, 920	82, 621, 742	168, 575, 680
1921	41, 863	378, 560	10, 846, 004	60, 939, 200	62, 653, 593	123, 840, 640
1922	74, 840	674, 240	15, 331, 099	87, 595, 200	93, 854, 737	189, 797, 440
Average	61, 221	562, 240	14, 441, 882	80, 725, 120	74, 149, 403	149, 132, 480

Year	Salmon—Continued					
	Red		Silver		Total	
	Number	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*
1909			27, 850	145, 600	39, 505, 289	177, 033, 920
1910	1, 653, 664	7, 468, 160	21, 000	107, 520	58, 146, 659	272, 101, 760
1911	3, 238, 676	14, 629, 440	723, 858	3, 767, 680	81, 898, 584	286, 888, 000
1912	2, 442, 862	11, 036, 480	435, 052	2, 251, 200	53, 753, 696	204, 733, 760
1913	2, 394, 892	10, 756, 480	257, 492	1, 332, 800	73, 398, 808	268, 741, 760
Average	1, 946, 018	8, 776, 320	293, 050	1, 520, 960	61, 340, 602	241, 902. 080
1914	1, 551, 011	7, 044, 800	366, 775	1, 892, 800	95, 798, 404	269. 931, 200
1915	2, 854, 075	12, 953, 920	345, 832	1, 787, 520	63, 053. 122	184, 681, 280
1916	6, 153, 805	27, 874, 560	640, 306	3, 308, 480	99, 294, 517	245, 609, 280
1917	3, 605, 949	16, 311, 680	581, 262	3, 001, 600	110, 789, 474	281, 417, 920
1918	4, 105, 919	18, 728, 640	723, 200	3, 760, 960	95, 993, 230	262, 386, 880
Average	3, 659, 352	16, 582, 720	531, 475	2, 750, 720	92, 985, 750	248, 805, 760
1919	6, 867, 560	31, 133, 760	1, 592, 205	8, 243, 200	81, 355, 328	244, 865, 600
1920	7, 184, 539	32, 504, 640	1, 512, 972	7, 835, 520	107, 609, 834	293, 292, 160
1921	2, 992, 822	13, 572, 160	559, 648	2, 896, 320	77, 093, 930	201, 626, 880
1922	6, 048, 860	27, 345, 920	837, 933	4, 327, 680	116, 147, 469	309, 740, 480
Average	5, 773, 436	26, 140, 800	1, 125, 689	5, 826, 240	95, 551, 640	262, 386, 880

[6] Does not include the catch of the eastern shores of Sakhalin Island, which has been very small, however.

Catch of fish in Russian far eastern waters—Continued

Year	Herring		Miscellaneous		Grand total	
	Number	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*
1909	9, 179, 640	4, 773, 440	1, 340, 133	4, 838, 400	50, 025, 063	186, 650, 240
1910	28, 710, 210	7, 226, 240	10, 000	35, 840	86, 866, 846	279, 363, 840
1911	40, 432, 000	9, 748, 480	8, 956	31, 360	122, 339, 540	296, 667, 840
1912	37, 249, 000	9, 385, 600	152, 663	551, 040	91, 155, 359	214. 670, 400
1913	4, 108, 340	13, 137, 600	356, 120	1, 285, 760	114, 863, 268	283, 167, 360
Average	31, 335, 838	8, 854, 720	373, 574	1, 346, 240	93, 050, 013	252, 103, 040
1914	60, 455, 851	23, 600, 640	233, 420	795, 200	156, 487, 675	294, 327, 040
1915	40, 733, 180	14, 360, 640	1, 325, 705	739. 200	105, 112, 007	199, 781, 120
1916	43, 649, 817	17, 727, 360	241, 755	526, 400	143, 186, 089	263, 863, 040
1917	40, 988, 637	17, 521, 280	328, 075	804, 160	152, 106, 186	299, 743, 360
1918	25, 067, 215	13, 552, 000	423, 534	822, 080	121, 483, 979	276, 760, 960
Average	42, 178, 940	17, 353, 280	510, 317	736, 960	135, 675, 186	266, 896, 000
1919	34, 693, 828	19, 176, 640	351, 993	887, 040	116, 401, 149	264, 929, 280
1920	35. 717, 891	22, 460, 480	516, 601	949, 760	143, 844, 326	316, 702, 400
1921	43, 275, 597	25, 919, 040	92, 713	224, 000	120, 462, 240	227, 769, 920
1922	50, 227, 627	24, 068, 800	340, 604	288, 960	166, 715, 700	334, 128, 240
Average	40, 978, 737	22, 906, 240	325, 478	586, 880	136, 855, 855	285, 880, 000

NOTE.—The weight of catch was derived by assuming that the average weight of each species was as follows: King, 9 pounds; keta, 5 pounds; humpback, 2 pounds; red, 3.5 pounds (in Okhotsk district 6) silver, 5 pounds (in Okhotsk 6); and herring, 0.5 pound (in southwestern district 0.7); as given in Fish and Fur Supplies of the Far East, by Dalrybokhota, 1923, pp. 110–126, 152. Vladivostok.

Relative importance of districts and of species of fish[1]

Item	Percentage share of each district	Percentage of total[2]			Percentage of each species of salmon[3]				
		Salmon	Herring	Others	King	Keta	Humpback	Red	Silver
All districts, Russian far east:									
Average, 1909–1913	100	95. 9	3. 5	0. 5	0. 1	72. 1	23. 6	3. 6	0. 6
1914–1918	100	93. 2	6. 5	. 3	. 1	31. 9	60. 2	6. 7	1. 1
1919–1922	100	91. 8	8. 0	. 2	. 2	30. 8	56. 8	10. 0	2. 2
Southwestern district:									
Average, 1909–1913	4. 3	15. 5	80. 6	3. 9	------	25. 0	75. 0	------	------
1914–1918	6. 7	1. 8	97. 1	1. 1	------	40. 1	59. 9	------	------
1919–1922	8. 1	1. 9	97. 5	. 6	------	38. 7	61. 3	------	------
Nikolayevsk-on-Amur district:									
Average, 1909–1913	55. 9	100. 0	------	------	------	91. 2	8. 8	------	------
1914–1918	17. 8	100. 0	------	------	------	64. 2	35. 8	------	------
1919–1922	11. 4	100. 0	------	------	------	64. 7	35. 3	------	------
Okhotsk district:									
Average, 1909–1913	1. 5	100. 0	------	------	------	93. 9	3. 8	. 6	1. 7
1914–1918	7. 0	99. 5	------	. 5	------	75. 8	22. 7	1. 2	3. 0
1919–1922	8. 4	99. 8	------	. 2	------	83. 8	14. 7	1. 1	. 4
Ichinsk and west Kamchatka district:									
Average, 1909–1913	27. 8	99. 1	------	. 9	------	32. 4	58. 3	8. 3	1. 0
1914–1918	56. 3	99. 8	------	. 2	------	9. 9	81. 5	7. 8	. 8
1919–1922	57. 5	99. 8	. 14	. 06	------	13. 2	75. 8	9. 9	1. 1
Karaginsk and east Kamchatka district:									
Average, 1909–1913	10. 5	98. 7	. 2	1. 1	. 4	74. 9	10. 3	11. 5	2. 9
1914–1918	12. 2	99. 3	. 5	. 2	. 8	61. 6	18. 5	14. 3	4. 8
1919–1922	14. 6	99. 4	. 2	. 4	1. 2	42. 7	23. 2	23. 4	9. 5

[1] According to weight of fish caught, based on the previous table.
[2] Total catch of fish taken as 100.
[3] Total catch of salmon taken as 100.

A study of the average catch (above table) by districts, shows that before the war the largest tonnage of fish came from the Nikolayevsk-on-Amur districts; since the war the largest tonnage of fish has come

from Kamchatka waters, particularly from the waters of the western shore. These returns also indicate that the salmons are the predominant species in Russian far eastern waters, representing over 90 per cent of all catches. Herring were a poor second, constituting from 3.5 to 8 per cent of the total catch and revealing a tendency toward a gradual though slow increase. The southwestern district accounted for nearly all herring caught in far eastern waters (81 to 98 per cent of the total catch of this species). In other districts salmon is supreme, catches of other species amounting to only fractions of 1 per cent.

Among the various species of salmon caught, keta or chum occupied first place before the war, representing 72 per cent of the total salmon catch. Lately this species has been replaced by the humpback, constituting around 60 per cent. Catches of red salmon also are tending to increase gradually—from 3.6 to 6.7 and 10 per cent. Catches of silver salmon represented from 1 to 2 per cent, and those of king salmon only a small fraction of 1 per cent. Keta or chum still dominates in the less important Nikolayevsk-on-Amur, Okhotsk, and eastern Kamchatka districts, while in the most important waters—the eastern shore of Kamchatka—humpback supplies the largest amount of fish, as well as in the southwestern district. Catches of red salmon are of importance only in Kamchatka waters, where along the eastern shores the major part of silver salmon is caught.

SOUTHWESTERN DISTRICT

The southwestern district is bordered by the Sea of Japan with a coast line 1,300 miles long, extending from Korea in the south up to the estuary of the Amur River in the north. Within this district are seven bays, where fishing, in accordance with the terms of the Russo-Japanese fisheries convention of 1909, is permitted to Russian nationals only. The most important of these are Peter the Great, Imperial, Port Vanin, and Possiet Bays. The principal species of fish in these waters is the herring (*Clupea pallasii* C. and V.), followed by salmon (humpback or "gorbusha") and dog salmon or "keta," which finds a good market in Vladivostok. Of secondary importance are the catches of trepang (*Stichopus japonicus*, Selenka), shrimp, oysters, crabs (*Paralithodes camchatica* ?), sea kelp (Laminaria sp.), and mussels (Mytilus).

The northern portion of this district, between the estuary of the Amur River and Cape Lazarev, is dominated by the Japanese, who prepare fertilizer from herring. The southern portion—Peter the Great and Possiet Bays—is confined to Russian fishermen, who recently introduced steam trawlers there and fished in this region throughout the year, selling their catch in Vladivostok, shipping it to the interior via the Trans-Siberian Railway, as well as exporting it to Korea, China, and Japan.

The most developed fisheries are on Peter the Great Bay (Vladivostok region), where the species are varied and fishing is carried on throughout the year. The most important fishery there is for herring. The catch of herring by commercial fishermen, in number, number

of stations, and average number of herring per station, for the period 1910–1922, is given below.

Year	Number of herring caught at fishing stations leased by the State	Number of stations	Average number of herring per station	Year	Number of herring caught at fishing stations leased by the State	Number of stations	Average number of herring per station
1910	6, 018, 000	180	38, 000	1917	22, 526, 721	80	281, 000
1911	4. 476, 000	128	35, 000	1918	19, 335, 164	69	280, 100
1912	5, 142, 000	123	41, 000	1919	26, 756, 264	98	273, 000
1913	10, 391, 000	76	136, 800	1920	23, 328, 616	96	243, 000
1914	16, 276, 000	88	187, 000	1921	34, 860, 061	84	416, 000
1915	16, 452, 000	80	205, 700	1922	34, 475, 409	105	328, 000
1916	22, 000, 000	80	250, 000				

NOTE.—Taken from Fish and Fur Supplies of the Far East, by Dalrybokhota, 1923, p. 15. Vladivostok.

These figures are very much lower than the actual catch. Adding the catch of the local population, which is from one-half to three-fifths of that caught by the commercial fisheries, the average annual catch of herring in that region is estimated at 60,000,000 to 65,000,000 fish. Owing to the loss of internal markets, the bulk of herring, fresh and salted, is exported to Korea, Japan, and China. Thus in 1919 Korea and Japan took 53 per cent of the catch; in 1920, 63 per cent; in 1921, 75 per cent.

Fishing is carried on near the shore and during the period of spawning, when the quality of fish is poor. Therefore, this product does not enjoy a high reputation, being fit only for unexacting markets, or being used for production of fertilizer or fish oil. Fish fertilizer is exported entirely, while fishery products, as well as poultry grit and other by-products used as feed stuffs, might find a market in Siberia.

Recently crab canning was begun there on a small scale. Small canneries were built in Valentin Bay, Nakhodka Bay, at Povorotnyi Cape near America Bay, at Bassargin Cape, on Popov Island near Troitza Bay, and in other places. The production of other plants was small. During 1923 one of the plants packed 820 cases, another 1,200 cases, and still another 2,000 cases.

Fishing for tuna and related species (*Thunnus alalunga, Th. thynnus, Seriola aureovitta*) is practically nonexistent there, although these species are common along the entire coast from the Korean boundary in the south up to Vanin Bay in Tartar Straits. This may be explained in part by the fact that this industry is unknown, and therefore is exposed to more risk because the fish run beyond the 3-mile limit and fishing for them requires vessels elaborately equipped. In 1913, however, a local firm started preliminary work for fishing for these species.

The production of sea kelp, mussels, and trepang has not been developed commercially. Some of these products are consumed locally, while others are exported to Korea and China. Edible mussels are abundant all along the main shore. In 1920 a trial pack was made at the canning plant at Povorotnyi Cape, the product being of quite satisfactory quality.

The total catch in the southwestern district for the period 1910 to 1919, in pounds, and the distribution by markets was as follows:

Year	Total catch [1]	Exported to Japan	Shipped to internal markets	Year	Total catch [1]	Exported to Japan	Shipped to internal markets
	Pounds	*Pounds*	*Pounds*		*Pounds*	*Pounds*	*Pounds*
1910	6, 944, 000	6, 944, 000	----------	1914	16, 614, 080	10, 566, 080	6, 048, 000
1911	12, 768, 000	10, 080, 000	2, 688, 000	1918	18, 665, 920	11, 200, 000	7, 465, 920
1912	11, 312, 000	7, 987, 840	3, 324, 160	1919	37, 334, 080	17, 808, 000	19, 526, 080
1913	12, 320, 000	8, 585, 920	3, 734, 080				

[1] From Fisheries of the Far Eastern Republic, p. 20. These figures do not coincide exactly with those given below, being taken from another authority and showing how much the reported returns of fish catches vary.

Catch of fish in southwestern district

Year	Salmon					
	King		Keta		Humpback	
	Number	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*
1909	----------	----------	19, 149	98, 560	537, 498	1, 079, 680
1910	----------	----------	45, 411	235, 200	480, 680	965, 440
1911	----------	----------	127, 567	658, 560	1, 027, 980	2, 063, 040
1912	47	----------	76, 837	396, 480	429, 274	862, 400
1913	----------	----------	138, 750	716, 800	657, 981	1, 321, 600
Average	9	----------	81, 543	421, 120	626, 683	1, 258, 880
1914	----------	----------	92, 163	474, 880	260, 102	501, 760
1915	----------	----------	19, 088	98, 560	65, 700	132, 160
1916	----------	----------	10, 889	58, 240	54, 760	109, 760
1917	----------	----------	1, 702	8, 960	41, 891	85, 120
1918	----------	----------	570	2, 240	58, 940	118, 720
Average	----------	----------	28, 884	127, 680	96, 279	190, 400
1919	----------	----------	14, 873	76, 160	38, 387	76, 160
1920	----------	----------	3, 013	15, 680	47, 510	94, 080
1921	----------	----------	65, 484	338, 240	231, 927	465, 920
1922	----------	----------	46, 100	237, 440	213, 600	427, 840
Average	----------	----------	32, 367	168, 000	132, 856	266, 560

Year	Salmon—Continued					
	Red		Silver		Total	
	Number	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*
1909	----------	----------	----------	----------	556, 647	1, 178, 240
1910	----------	----------	----------	----------	526, 091	1, 200, 640
1911	----------	----------	----------	----------	1, 155, 547	2, 721, 600
1912	----------	----------	7	----------	506, 158	1, 258, 880
1913	1, 915	8, 960	----------	----------	798, 646	2, 047, 360
Average	383	2, 240	1	----------	708, 618	1, 682, 240
1914	----------	----------	----------	----------	352, 265	976, 640
1915	----------	----------	----------	----------	84, 788	230, 720
1916	----------	----------	----------	----------	65, 649	168, 000
1917	----------	----------	817	4, 480	44, 410	98, 560
1918	----------	----------	62	----------	59, 578	120, 960
Average	----------	----------	176	----------	121, 338	318, 080
1919	----------	----------	507	2, 240	53, 767	154, 560
1920	----------	----------	----------	----------	50, 523	109, 760
1921	----------	----------	----------	----------	297, 411	804, 160
1922	----------	----------	----------	----------	259, 700	665, 280
Average	----------	----------	127	----------	165, 350	434, 560

Catch of fish in southwestern district—Continued

Year	Herring		Miscellaneous		Grand total	
	Number	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*
1909	9, 179, 640	4, 773, 440	160, 000	577, 920	9, 896, 288	6, 529, 600
1910	28, 710, 210	7, 226, 240			29, 236, 301	8, 424, 640
1911	40, 407, 000	9, 737, 280			41, 562, 547	12, 458, 880
1912	36, 680, 500	9, 116, 800	76, 750	277, 760	37, 263, 408	10, 653, 440
1913	40, 919, 600	13, 050, 240	356, 120	1, 285, 760	42, 074, 366	16, 383, 360
Average	31, 179, 390	8, 780, 800	118, 574	427, 840	32, 006, 582	10, 890, 880
1914	60, 420, 888	23, 584, 960	233, 020	792, 960	61, 006, 173	25, 354, 560
1915	40, 586, 012	14, 295, 680	1, 165, 686	161, 280	41, 836, 486	14, 687, 680
1916	43, 216, 580	17, 516, 800	100, 000	13, 440	43, 382, 229	17, 698, 240
1917	40, 825. 870	17, 442, 880	109, 368	15, 680	40, 979, 648	17, 557, 120
1918	24, 998, 934	13, 520, 640	204, 168	29, 120	25, 262, 680	13, 670, 720
Average	42, 009, 657	17, 272, 640	362, 448	201, 600	42, 493, 443	17, 792, 320
1919	34, 331, 364	19, 001, 920	110, 341	15, 680	34, 495, 472	19, 172, 160
1920	35, 102, 180	22, 164, 800	380, 570	459, 200	35, 533, 273	22, 733, 760
1921	42, 875, 561	25, 726, 400	38, 633	26, 880	43, 211, 605	26, 557, 440
1922	49, 931, 611	23, 925, 440	271, 000	38, 080	50, 462, 311	24, 628, 800
Average	40, 560, 179	32, 704, 640	200, 136	134, 400	40, 925, 665	23, 273, 600

Besides food products, other fishery products prepared in 1913 included 1,570 tons of fish fertilizer, 1,866 tons of sea kelp, 280,000 pounds of crabs, 64,960 pounds of shrimp, and 20,160 pounds of trepang. The relative number of each species caught in conventional and nonconventional waters are shown by the figures for 1913, as given in the table below.

Species	Total catch	Unconventional waters	Conventional waters
	Number	*Number*	*Number*
Herring	41, 000, 000	16, 000, 000	25, 000, 000
Humpback salmon	658, 000	213, 000	445, 000
Dog salmon	138, 000	102, 000	36, 000
Smelt	3, 400, 000	3, 400, 000	
Others	2, 738, 000	2, 257, 000	481, 000
Total	47, 934, 000	21, 972, 000	25, 962, 000

NOTE.—Compare with returns at the top of pages 49 and 50.

NIKOLAYEVSK-ON-AMUR DISTRICT

The Nikolayevsk-on-Amur district comprises the lower reaches of the Amur River, 300 miles in length, and its tributary, the Amgun River, 200 miles long; the Amur estuary, 150 miles long; the western coast of Sakhalin Island, 130 miles long; and the coast of the Okhotsk Sea within Udsk County, 865 miles long. It is one of the most important fishing districts in the Russian far east and one of great fishing enterprise. Russian nationals alone have the right to fish in the Amur River. Japanese are entitled to lease salting stations but not fishing stations, and only in the river section below the city of Nikolayevsk.

In this district the more modern methods of preparing fish and fishery products were first applied. Fish were more carefully selected, cleaned, washed, and salted. A cold-storage plant and a canning factory were erected. Salmon caviar, which has heretofore had a negligible market, under the direction of Volga fishermen has been transformed into a high-priced product of more value than the

fish itself. The quantity of Russian caviar prepared in certain years follows: In 1909, 2,329,600 pounds; 1910, 3,129,280 pounds; 1911, 2,515,520 pounds; 1912, 2,623,040 pounds; 1913, 2,479,680 pounds; 1918, 985,600 pounds.

Fishing stations in this district are of two types—(*a*) those where fishing alone is carried on and (*b*) those where the salting of fish purchased from local fishermen or natives and peasants is done. Before the Russo-Japanese War most of the catch was exported to Japan. Japanese nationals, by financing the Russians, dominated the fishing industry to a large extent. The heavy terms of credit and low prices offered for fish by the Japanese compelled the Russian fishermen to look to other markets, and shipments to Japan began to decline. This decline is illustrated in the following table, showing the catch of fish by industrial fisheries and the exports to Japan and internal markets during the period 1892 to 1914.[7]

Year	Total catch	Exported to Japan	Domestic consumption	Year	Total catch	Exported to Japan	Domestic consumption
	Pounds	*Pounds*	*Pounds*		*Pounds*	*Pounds*	*Pounds*
1892	7, 913, 920	185, 920	7, 728, 000	1904	63, 651, 840	21, 241, 920	42, 409, 920
1893	5, 712, 000	560, 000	5, 152, 000	1905	60, 368, 000		60, 368, 000
1894	5, 635, 840	1, 120, 000	4, 515, 840	1906	98, 336, 000	26, 505, 920	71, 827, 840
1895	7, 168, 000	2, 240, 000	4, 928, 000	1907	81, 648, 000	45, 545, 920	36, 099, 840
1896	11, 833, 920	4, 105, 920	7, 728, 000	1908	79, 667, 840	45, 433, 920	34, 233, 920
1897	37, 856, 000	27, 401, 920	10, 451, 840	1909	106, 137, 920	44, 313, 920	61, 824, 000
1898	43, 120, 000	34, 720, 000	8, 400, 000	1910	126, 371, 840	46, 217, 920	80, 153, 920
1899	67, 161, 920	56, 224, 000	10, 937, 920	1911	112, 483, 840	37, 968, 000	74, 515, 840
1900	105, 539, 840	96, 953, 920	8, 585, 920	1912	110, 841, 920	16, 313, 920	94, 528, 000
1901	80, 713, 920	69, 587, 840	9, 555, 840	1913	129, 993, 920	13, 513, 920	116, 480, 000
1902	89, 824, 000	74, 067, 840	15, 753, 920	1914	79, 369, 920	12, 169, 920	67, 200, 000
1903	108, 528, 000	92, 697, 920	15, 827, 840				

The following table gives the number of humpback and dog salmon caught by industrial establishments during the period 1909–1917:

Year	Total catch	Humpback	Dog salmon	Year	Total catch	Humpback	Dog salmon
	Number	*Number*	*Number*		*Number*	*Number*	*Number*
1909	16, 641, 000	2, 209, 000	14, 432, 000	1914	13, 409, 000	9, 314, 000	4, 095, 000
1910	23, 426, 000	5, 076, 000	18, 350, 000	1915	3, 477, 000	285, 000	3, 192, 000
1911	18, 057, 000	2, 621, 000	15, 436, 000	1916	3, 873, 000	2, 887, 000	986, 000
1912	16, 790, 000	5, 822, 000	10, 868, 000	1917	2, 091, 000	222, 000	1, 869, 000
1913	17, 997, 000	5, 688, 000	12, 309, 000				

The following statistics show the number of salmon prepared for the Russian and Japanese markets for the same period: [8]

Year	Total	Russian market		Japanese market	
		Humpback salmon	Dog salmon	Humpback and chum salmon, fresh and salted	Humpback and chum salmon, frozen
	Number	*Number*	*Number*	*Number*	*Number*
1909	16, 897, 000	145, 000	2, 275, 000	14, 272, 000	205, 000
1910	23, 140, 000	1, 005, 000	4, 472, 000	17, 305, 000	358, 000
1911	17, 753, 000	523, 000	4, 522, 000	12, 474, 000	234, 000
1912	20, 752, 000	1, 154, 000	10, 617, 000	8, 761, 000	222, 000
1913	17, 967, 000	4, 806, 000	9, 820, 000	3, 065, 000	276, 000
1914	3, 416, 000	6, 354, 000	3, 789, 000	3, 259, 000	14, 000

[7] Fisheries of the Far Eastern Republic, p. 13.

[8] None were exported during 1915, 1916, and 1917.

In addition to the operations of professional fishermen, considerable fishing was carried on by the local population (natives and Russian peasants), partly for their own use and partly for sale. The following table shows the volume of this catch and its disposition during the period 1909–1918:

Year	Total catch	Humpback	Chum	Humpback and chum		By-products sold	
				Consumed locally	Sold fresh	Caviar	Others
	Number	*Number*	*Number*	*Number*	*Number*	*Pounds*	*Pounds*
1909	9, 006, 000	140, 000	8, 866, 000	2, 784, 000	4, 251, 000	423, 360	15, 765, 120
1910	17, 858, 000	2, 625, 000	15, 233, 000	5, 297, 000	8, 559, 000	380, 800	2, 450, 560
1911	10, 158, 000	1, 234, 000	8, 924, 000	2, 831, 000	5, 457, 000	383, 040	12, 871, 040
1912	9, 289, 000	1, 706, 000	7, 583, 000	2, 371, 000	4, 283, 000	472, 640	10, 442, 880
1913	9, 390, 000	1, 780, 000	7, 610, 000	2, 576, 000	4, 932, 000	504, 000	9, 255, 680
1914	9, 221, 000	5, 213, 000	4, 008, 000	2, 975, 000	4, 655, 000	412, 160	8, 393, 280
1915	3, 227, 000	502, 000	2, 725, 000	----------	----------	----------	----------
1916	4, 046, 000	2, 963, 000	1, 073, 000	----------	----------	----------	----------
1917	2, 324, 000	266, 000	2, 058, 000	367, 000	559, 000	172, 480	10, 010, 560
1918	9, 445, 000	7, 840, 000	1, 605, 000	----------	549, 000	409, 920	----------

NOTE.—From Fisheries of the Far Eastern Republic, p. 17.

Another source gives the catch of fish as follows:

Nikolayevsk-on-Amur district

Year	Keta				Total keta	
	Summer		Fall			
	Number	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*
1909	13, 929, 181	71, 892, 800	7, 870, 739	56, 873, 600	21, 799, 920	128, 766, 400
1910	21, 384, 549	110, 371, 520	9, 546, 254	68, 978, 560	30, 930, 803	179, 350, 080
1911	15, 369, 783	79, 327, 360	7, 181, 725	51, 894, 080	22, 551, 508	131, 221, 440
1912	10, 370, 998	53, 527, 040	5, 626, 885	40, 658, 240	15, 997, 883	94, 185, 280
1913	11, 542, 170	59, 572, 800	6, 820, 203	49, 280, 000	18, 362, 373	108, 852, 800
Average	14, 519, 336	74, 939, 200	7, 409, 161	53, 538, 240	21, 928, 497	128, 475, 200
1914	3, 872, 251	19, 992, 000	3, 757, 922	27, 153, 280	7, 630, 173	47, 145, 280
1915	3, 523, 301	18, 184, 320	3, 390, 277	24, 496, 640	6, 913, 578	42, 680, 960
1916	704, 021	3, 633, 280	1, 411, 483	10, 198, 720	2, 115, 504	13, 832, 000
1917	1, 876, 997	9, 688, 000	2, 053, 633	14, 840, 000	3, 930, 630	24, 528, 000
1918	642, 959	3, 317, 440	2, 933, 770	21, 192, 640	3, 576, 729	24, 510, 080
Average	2, 123, 905	10, 962, 560	2, 709, 417	19, 575, 360	4, 833, 322	30, 537, 920
1919	725, 000	3, 743, 040	2, 875, 000	20, 773, 760	3, 600, 000	24, 516, 800
1920	300, 000	1, 547, 840	----------	----------	300, 000	1, 547, 840
1921	200, 000	1, 032, 640	2, 400, 000	17, 346, 560	2, 600, 000	18, 379, 200
1922	700, 000	3, 613, 120	5, 000, 000	36, 128, 960	5, 700, 000	39, 742, 080
Average	481, 250	2, 484, 160	2, 568, 750	18, 562, 880	3, 050, 000	21, 047, 040

Year	Humpback		Total salmon	
	Number	*Pounds*	*Number*	*Pounds*
1909	2, 949, 860	6, 269, 760	24, 749, 780	135, 036, 160
1910	7, 701, 394	15, 762, 880	38, 632, 197	195, 112, 960
1911	3, 856, 391	8, 196, 160	26, 407, 899	139, 417, 600
1912	7, 527, 541	15, 998, 080	23, 525, 424	110, 183, 360
1913	7, 468, 794	15, 872, 640	25, 831, 167	124, 725, 440
Average	5, 900, 796	12, 420, 800	27, 829, 293	140, 896, 000
1914	14, 528, 262	30, 876, 160	22, 158, 435	78, 021, 440
1915	994, 396	2, 112, 320	7, 907, 974	44, 793, 280
1916	9, 163, 813	19, 476, 800	11, 279, 317	33, 308, 800
1917	488, 709	1, 039, 360	4, 419, 339	25, 567, 360
1918	14, 876, 390	31, 615, 360	18, 453, 119	56, 125, 440
Average	8, 010, 314	17, 024, 000	12, 843, 636	47, 561, 920
1919	420, 000	891, 520	4, 020, 000	25, 408, 320
1920	12, 000, 000	25, 502, 400	12, 300, 000	27, 050, 240
1921	200, 000	425, 600	2, 800, 000	18, 804, 800
1922	9, 000, 000	19, 129, 600	14, 700, 000	58, 871, 680
Average	5, 405, 000	11, 486, 720	8, 455, 000	32, 533, 760

NOTE.—Grand total is the same as "Total salmon."

The importance of this district, absolutely and relatively, declined steadily. For the period 1909–1913 production amounted to about 141,120,000 pounds, or 56 per cent of the total catch in the Russian far eastern waters; in 1914–1918 about 47,040,000 pounds, or 18 per cent; and in 1919–1922, about 33,600,000 pounds, or 11 per cent.

Fish for the Russian market, either frozen or salted, are shipped in barrels of about 900 pounds' capacity. Fish destined for Japanese markets are dry salted and not packed in barrels.

Of late an interesting feature of the fishing industry in the Amur district is the growing fall fishery of fresh chum salmon for export to Japan in special steam or motor vessels. The salmon are packed in iced boxes, to which a small quantity of salt is added. The duration of the trip of such freighters is four to five days, and the chum reach the Japanese markets in good condition. The profitableness of the venture is illustrated by the number of such refrigerator vessels, there having been 20 in 1920, more than double that number in 1921, while in 1922 about 30 vessels came to one of the fishing stations.

The refrigerating industry in Japan is developing rapidly. This may influence not only the fishing industry of Amur but also of other districts in the Russian far east, replacing exports of fish crudely salted by fishery products of better quality. It is estimated that 600,000 to 700,000 fresh fish were exported to Japan in 1922, while for the Russian market not more than 3,360,000 to 4,480,000 pounds of salted fish were prepared. In 1922 the number of hands employed in the Amur district was 11,200 (5,000 Japanese, 3,600 Russians, 1,400 Chinese, and Koreans, and about 1,200 of the local population).

The catches of salmon in this district are steadily declining. The most important cause of this is the spoliatory fishing by the local population on the spawning grounds—that is, at the heads of creeks and in the lakes of the middle and lower course of the Amur River. In these areas the local population catches all the fish, including the spawners, for the sake of their eggs for caviar. The flesh of the fish when taken on the spawning grounds is not fit for consumption. This condition might be helped by the promulgation of laws prohibiting fishing and also by the establishment of hatcheries. In order to avoid the depletion of salmon in far eastern waters, hatcheries are necessary—first, because salmon spawn only once in their lifetime, and second, because the number of eggs produced by salmon is relatively small in comparison with those from other species. These unfavorable conditions are still more accentuated by the adverse factors affecting the development of eggs into fry and the great losses of the latter, with the result that only a small percentage of them reach adult age.

Besides salmon, the catch of sturgeon—especially in the wintertime—is of importance, particularly for local consumption. Between Khabarovsk and Nikolayevsk fishing of importance to the local population is being carried on, very little of this production reaching markets for sale, however.

OKHOTSK-KAMCHATKA REGION

The Okhotsk-Kamchatka region is subdivided into the following districts: Okhotsk, Ichinski, western Kamchatka, Karaginskii, and eastern Kamchatka. The most important are western and eastern

Kamchatka and Okhotsk, in which the canning industry took root. In 1922 there were 20 Japanese and 6 Russian canning plants, which produced about 900,000 cases of various species of salmon. Of these, 5 were located in east Kamchatka and 14 in west Kamchatka, with a production of 718,184 cases.

The number of streams known as spawning grounds for salmon is not large. They are as follows:

District	Miles of coast line	Number of spawning streams
Okhotsk		24
Gizhiga	1,620	4
Ichinski	550	21
West Kamchatka	330	16
East Kamchatka	1,840	7
Karaginskii		12
Oliutorsko-Navarinski		20

Of these 104 streams, about 20 to 25 are important as spawning grounds, such as Okhota, Kukhtuy, Gizhiga, Tigil, Kol, Vorovskaya, Bolshaya, Kamchatka, Anadyr, and others. Usually in each stream of a district there is a run of certain species of fish, usually not more than two or three species. Only Kamchatka and Bolshaya streams have runs of all five salmon species annually.

The number of fishing stations leased to Russians and Japanese for the years 1910–1923 is given below.

Year	Number of fishing stations leased to Japanese	Number of fishing stations leased to Russians		Total	Year	Number of fishing stations leased to Japanese	Number of fishing stations leased to Russians		Total
		Conventional waters	Unconventional waters				Conventional waters	Unconventional waters	
1910 [1]	157	34		191	1917	218	69	138	425
1911 [1]	214	41		255	1918	245	77	206	528
1912 [1]	215	29		244	1919	247	84	198	529
1913 [1]	220	50		270	1920	[2] 311	[3] 77	195	583
1914	231	37	204	472	1921	307	[4] 82	153	542
1915	231	32	145	408	1922	307	[3] 81	161	549
1916	204	38	159	401	1923	[5] 269	[3] 41	97	407

[1] Number represents those actually exploited.
[2] Includes 4 crab stations.
[3] Includes 1 crab station.
[4] Includes 2 crab stations.
[5] Includes 14 crab stations.

NOTE.—From Fish and Fur Supplies of the Far East, 1923, p. 61.

The catch of fish, by species in number and weight in pounds, is shown on pages 57 to 62.

To the catch of salmon, as given in these tables, it is necessary to add the catch of salmon by the local population for its own consumption and for feeding its dogs. For Kamchatka alone it is estimated that these two items amount to about 20,000,000 salmon (4,500,000 for the people and 15,500,000 for the dogs).

It is estimated that in 1922 the total catch of salmon by the local population for its own consumption, feeding of dogs, and for sale, and by commercial fishermen, was about 120,000,000 in number. Commercial fishermen caught over 91,000,000, weighing about 448,000,000 pounds, of which 83 per cent are accredited to ocean fishing stations and 17 per cent to river stations.

How widely the Kamchatka-Okhotsk waters have been used by the Japanese is revealed in the following table, showing the number of sailing and steam vessels chartered by Japanese fishermen, their tonnage, number of workmen, weight of fish caught (in pounds), and species for the period 1910–1921:

Japanese fisheries in Russian far eastern waters

[According to Japanese official statistics]

Year	Number of fishing stations	Number of vessels, not including those chartered by Russians				Number of workmen	Total production of fish and fishery products
		Steamers		Schooners			
		Number	*Tonnage*	*Number*	*Tonnage*		*Pounds*
1910	152	33	13, 190	242	30, 787	4, 938	81, 229, 120
1911	214	70	40, 612	299	38, 252	7, 616	136, 409, 280
1912	213	80	50, 509	286	38, 561	9, 751	75, 528, 320
1913	231	95	73, 056	265	36, 007	10, 676	123, 103, 680
1914	226	96	71, 333	234	32, 715	10, 031	154, 374, 080
1915	230	104	81, 902	211	35, 103	10, 717	137, 168, 640
1916	201	109	94, 143	268	40, 030	9, 929	161, 331, 520
1917	213	106	79, 228	249	36, 918	10, 418	149, 163, 840
1918	225	139	96, 233	227	36, 279	10, 986	138, 573, 120
1919	246	84	73, 834	225	36, 341	13, 200	154, 689, 920
1920	260	153	42, 518	190	32, 635	13, 268	184, 564, 800
1921	227	125	121, 657	162	28, 705	12, 556	195, 059, 200

NOTE.—From Fish and Fur Supplies of the Far East, 1923, pp. 72–73.

The Japanese financed the Russian fishermen, furnished the equipment and necessary materials, vessels for transportation of workmen, etc. From the port of Hakodate alone there were exported to traders in the Russian far eastern waters equipment and supplies for fisheries to the amount of $4.220,000 in 1919, $6,670,000 in 1920, $4,160,000 in 1921, and $6,630,000 in 1922. A portion of the fish caught in Russian far eastern waters were exported by the Japanese to Quantung and Hongkong, China, as follows:

Exports by the Japanese of salted humpback salmon caught in Russina waters

Year	China		Quantung		Asiatic Russia		Hongkong		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
1911	3, 449, 600	$48, 450	6, 720	$140					3, 456, 320	$48, 590
1912	1, 680, 000	29, 830	291, 200	4, 930					1, 971, 200	34, 760
1913	8, 825, 600	162, 410	1, 478, 400	27, 400					10, 304, 000	189, 810
1914	27, 148, 800	428, 270	1, 388, 800	26, 830					28, 537, 600	455, 100
1915	36, 355, 200	574, 960	22, 400	330					36, 377, 600	575, 290
1916	21, 504, 000	443, 540	179, 200	3, 850	190, 400	$10, 880	492, 800	$5, 530	22, 366, 400	463, 800
1917	22, 556, 800	571, 070	604, 800	15, 230	1, 680, 000	42, 330			24, 841, 600	631, 630
1918	20, 563, 200	751, 480	2, 844, 800	118, 230	268, 800	9, 260			23, 676, 800	878, 970
1919	10, 595, 200	426, 430	9, 273, 600	489, 570			380, 800	18, 740	20, 249, 600	934, 740
1920	12, 992, 000	450, 470	7, 616, 000	376, 830	44, 800	1, 270	940, 800	36, 270	21, 593, 600	864, 840
1921	20, 048, 000	504, 340	5, 622, 400	164, 370	2, 240	100	291, 200	9, 480	25, 963, 840	678, 290

NOTE.—From Fish and Fur Supplies of the Far East, 1923, p. 77.

CANNING

The growth of the Japanese canning industry, which was participated in in only two cases by American and English capital, for the period from 1910 to 1923, by species, is shown in the following table:

Siberian salmon pack

Year	King	Red	Silver	Chum	Humpback	Total
	Cases	*Cases*	*Cases*	*Cases*	*Cases*	*Cases*
1910	----------	5, 500	2, 500	2, 000	----------	10, 000
1911	----------	15, 000	6, 000	4, 000	----------	25, 000
1912	----------	43, 500	18, 000	1, 600	----------	63, 100
1913	----------	102, 900	7, 000	21, 000	2, 500	133, 400
1914	----------	85, 000	22, 500	27, 000	2, 000	136, 500
1915	3, 334	154, 703	28, 191	92, 781	10, 000	289, 009
1916	----------	177, 800	50, 000	81, 000	117, 000	425, 800
1917	2, 556	275, 212	29, 918	66, 055	137, 197	511, 001
1918	2, 027	296, 960	43, 588	23, 585	15, 177	381, 337
1919	5, 108	377, 290	106, 364	101, 983	157, 766	748, 511
1920	10, 249	361, 539	128, 158	19, 875	75, 950	595, 771
1921	15, 233	433, 243	74, 721	98, 729	83, 567	705, 493
1922	332	538, 587	51, 457	24, 194	103, 614	718, 184
1923	----------	585, 338	22, 035	29, 427	66, 869	[1] 703, 669

[1] Of the total number, 28,956 cases were packed by Russian interests on the Bolshaya River.

NOTE.—From Fish and Fur Supplies of the Far East, 1923, p. 84.

These plants represented 75 per cent of all canneries, the remainder being scattered at different places.

Recently plants for canning crabs were established on the western and eastern coasts of Kamchatka, where crabs are to be found in abundance. This is especially true of the western coast, particularly in the region of Ozernaya Creek up to Lopatka Cape. The giant spider crab, *Macrocheira kaempferi*, is of particular interest, although the common Kamchatka spider crab, *Paralithodes camchatica*, is mostly caught by the fishermen there. The male of the giant spider crab averages 5½ to 9 pounds, reaching as high as 18 pounds; the female averages 2 to 4½ pounds, although some specimens with eggs attain a weight of 9 pounds. The fishery is carried on in two seasons—spring and fall. The depth from which the crabs are taken is usually between 140 and 175 feet and does not exceed 350 feet. The map of Kamchatka Peninsula and Okhotsk Sea (fig. 2) shows the location in that region of the most important fisheries for salmon, cod, crabs, and other sea animals.

OKHOTSK DISTRICT

The Okhotsk district occupies the eastern shore of the Okhotsk Sea and is about 2,400 miles long. The climate is severe, and fishing is of recent development. This district is considered not to have abundant fish supplies, and in order to provide the natives with sufficient fish (their principal item of food) fishing has been prohibited since 1913 in many of its bays, such as Ulya, Arka, Okhota, Kukhtul, Kola, Tau, Yana, Arman, Ola, Yama, and Nayakhan. The output of this district was 5,434,240 pounds in 1911, 7,226,240 pounds in 1912, and 7,721,280 pounds in 1913. Besides fish, this district prepared 463,680 pounds of Russian caviar in 1913.

The chief species are dog salmon and humpback. In 1913 there were caught 1,235,000 dog salmon, 245,000 humpbacks, and 20,000 salmon of other species. The yearly average catch for 1920 and 1921 was 3,500,000 dog salmon, 800,000 humpbacks, and 100,000 red and silver salmon.

NAMES OF THE RIVERS SHOWN IN FIGURE 2

1=Kheveran.
2=Kaluerka.
3=Kiliyu.
4=Ilgun.
5=Chemyguiya.
6=Vurvaren.
7=Velmo.
8=Vakai.
9=Cheguyan.
10=Tyrguey.
11=Amguema.
12=Chernaya.
13=Taniurer.
14=Ennenkoi.
15=Tan-leo.
16=Volchiya.
17=Belaya.
18=Chisey-iney.
19=Bolshaya.
20=Khatyrka.
21=Opuka.
22=Opuka.
23=Tunguska.
24=Krasnaya.
25=Berezovka.
26=Anadyr.
27=Schuchya.
28=Berezovaya.
29=Malaya Main.
30=Main.
31=Algan.
32=Vaggi.
33=Anetva.
34=Sobachiya.
35=Anadyr.
36=Baraniya.
37=Daraniya.
38=Vorozheya.
39=Grebenka.
40=Trokkha.
41=Volosatik.
42=Yeropaya.
43=Sergueyevka.
44=Yablonovaya.
45=Schechka.
46=Orlovka.
47=Kovrizhka.
48=Chernaya.
49=Slovuchnaya.
50=Kondereva.
51=Penzhina.
52=Ushkanikha.
53=Prodolnaya.
54=Poperechnaya.
55=Poperechnaya.
56=Poperechnaya.
57=Glotova.
58=Oliutora.
59=Govenka (Telichin).
60=Vivniki.
61=Talovka.
62=Zhirovaya.
63=Kamenka.
64=Mikina.
65=Tilkhina.
66=Paren.
67=Chernaya.
68=Akhvaven.
69=Turolga.
70=Avekova.
71=Virkhaloma.
72=Nayakhan.
73=Topolevka.
74=Tanlat.
75=Karaga.
76=Lesnaya.
77=Pankara.
78=Rusakova.
79=Kholiuliya.
80=Kangalat.
81=Uka.
82=Konkil.
83=Palana.
84=Tiguil.
85=Sedanka.
86=Yelovka.
87=Kavran.
88=Belogolovaya.
89=Moroshechnaya.
90=Sopochnaya.
91=Kozyrevskaya.
92=Kamchatka.
93=Krutogorova.
94=Konpakova.
95=Vorovskaya.
96=Nykchik.
97=Kungas.
98=Utki.
99=Bolshaya.
100=Bystraya.
101=Chupanova.
102=Opala.
103=Ozernaya.
104=Shirokaya.
105=Propaschaya.
106=Viliga.
107=Naninmada.
108=Tuman.
109=Tupukhovka.
110=Tugulen.
111=Tokhtoyan.
112=Iret.
113=Malkachan.
114=Yana.
115=Perevolochnaya.
116=Siglan.
117=Ola.
118=Arman.
119=Yana.
120=Taui.
121=Chalemzha.
122=Ingagli (Topolevka).
123=Kova.
124=Shilkan.
125=Amat.
126=Uniya.
127=Iniya.
128=Ulbeya.
129=Marekanka.
130=Kukhtui.
131=Burganan.
132=Chainka.
133=Okhota.
134=Arka.
135=Estanda.
136=Yudoma.
137=Anachan.
138=Okhota.
139=Urak.
140=Konova.
141=Kursen.
142=Khomet.
143=Andych.
144=Yelzian.
145=Ulrya.
146=Turbi.
147=Rurka.
148=Mana.
149=Kuliukla.
150=Aradia.
151=Tom.
152=Unma.
153=Guiunchi.
154=Ogonkan.
155=Ui.
156=Pana.

In 1920 there were 66 fishing stations leased in covenanted waters. In uncovenanted waters there were 15 fishing stations and 33 salting stations. The catch, as given by another authority, was as follows:

Okhotsk district

Year	Salmon							
	Keta		Humpback		Red		Silver	
	Number	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*
1909	109, 490	564, 480	60				3, 824	22, 400
1910	86, 595	448, 000						
1911	895, 351	4, 621, 120					37, 790	228, 480
1912	1, 173, 713	6, 056, 960	109, 580	219, 530	8, 961	53, 760	8, 749	51, 520
1913	1, 235, 050	6, 375, 040	245, 266	492, 800	12, 000	71, 680	3, 198	20, 160
Average	700, 040	3, 613, 120	70, 981	143, 360	4, 192	24, 640	10, 712	64, 960
1914	1, 732, 793	8, 944, 320	1, 474, 066	2, 959, 040	26, 003	156, 800	411	2, 240
1915	2, 011, 393	10, 382, 400	2, 363, 430	4, 744, 320	39, 350	237, 440	2, 250	13, 440
1916	2, 289, 993	11, 818, 240	3, 252, 795	6, 529, 600	56, 348	338, 240	4, 139	24, 640
1917	3, 556, 956	18, 359, 040	1, 005, 774	2, 018, 240	12, 676	76, 160	1, 882	11, 200
1918	3, 970, 393	20, 493, 760	2, 375, 694	4, 768, 960	45, 497	273, 280	35, 761	215, 040
Average	2, 712, 306	14, 000, 000	2, 094, 352	4, 204, 480	35, 975	217, 280	8, 889	53, 760
1919	3, 205, 868	21, 925, 120	464, 296	931, 840	79, 745	479, 360	27, 508	165, 760
1920	5, 061, 424	26, 122, 880	3, 553, 627	7, 132, 160	38, 704	232, 960	27, 810	168, 000
1921	2, 391, 603	12, 344, 640	1, 514, 364	3, 039, 680	36, 016	217, 280	8, 675	51, 520
1922	3, 878, 044	20, 014, 400	1, 506, 488	3, 024, 000	17, 784	107, 520	3, 784	22, 400
Average	3, 634, 235	20, 101, 760	1, 759, 694	3, 532, 480	43, 053	259, 840	16, 944	103, 040

Okhotsk district—Continued

Year	Salmon—Continued Total		Herring		Miscellaneous		Grand total	
	Number	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*
1909	113,374	586,880			4,316	15,680	117,690	602,560
1910	86,595	448,000					86,595	448,000
1911	933,141	4,849,600					933,141	4,849,600
1912	1,301,003	6,381,760					1,301,003	6,381,760
1913	1,495,514	6,959,680					1,495,514	6,959,680
Average	785,925	3,846,080			863	2,240	786,788	3,846,080
1914	3,233,273	12,062,400					3,233,273	12,062,400
1915	4,416,423	15,377,600					4,416,423	15,377,600
1916	5,603,275	18,710,720	200		28,596	103,040	5,632,071	18,813,760
1917	4,577,288	20,464,640	200		57,102	206,080	4,634,590	20,670,720
1918	6,427,345	25,751,040	486		37,644	136,640	6,465,475	25,887,680
Average	4,851,522	18,475,520	177		24,668	89,600	4,876,366	18,565,120
1919	3,777,417	23,502,080	200		6,756	24,640	3,784,373	23,526,720
1920	8,681,565	33,656,000	1,355		45,007	163,520	8,727,927	33,819,520
1921	3,950,658	15,653,120			980	4,480	3,951,638	15,657,600
1922	5,406,100	23,168,320	35,060	17,920	830	2,240	5,441,999	23,188,480
Average	5,453,935	23,997,120	9,156	4,480	13,393	49,280	5,476,484	24,053,120

WEST KAMCHATKA DISTRICT

The west Kamchatka fisheries are along the west coast of Kamchatka Peninsula, occupying a seacoast 800 miles long. Along this coast fishing has been forbidden near the mouths of a number of rivers, such as Ozernaya, Goliguina, Opala, Bolshaya, Kol, Vorovskaya, Kolpokara, Oblukovina, and Tigil. Until recently the Bolshaya River was the scene of the most active fishing in this region, but the stations are gradually moving toward the northern portion of the coast. This region, being opened recently, attracted great attention, especially on the part of Japanese fishermen. The number of fishing stations was 109 in 1909, 102 in 1910, 139 in 1911, 133 in 1912, 148 in 1913, and 179 in 1920. Their output increased from 34,720,000 pounds in 1909 to 53,536,000 pounds in 1910, 108,192,000 pounds in 1911, 55,104,000 pounds in 1912, and 84,224,000 pounds in 1913, which included 2,240,000 pounds of Russian caviar. To these figures are to be added the river catch, which in 1911 was 8,064,000 pounds; 1912, 6,272,000 pounds; and 1913, 8,960,000 pounds, including 481,600 pounds of Russian caviar. The Russian authorities also became interested in these fisheries and began to finance Russian fishermen, even sending instructors to improve methods of salting fish. Their activities resulted in a change of markets from uncovenanted river waters.

In 1911, 58 per cent of all the fish and fishery products from uncovenanted waters were exported to Japan; in 1912, 30 per cent; and in 1913 only 21 per cent. In 1913 the catch in this district was as follows:

Species	Total	Covenanted waters	Uncovenanted waters
	Number	*Number*	*Number*
Humpback	27,300,000	25,500,000	1,800,000
Keta (chum)	4,500,000	4,100,000	400,000
Red salmon	1,500,000	1,300,000	200,000
Silver salmon	100,000	70,000	30,000
Total	33,400,000	30,970,000	2,430,000

Of the catch in 1913, 6,272,000 pounds were shipped to the Russian market, 83,776,000 pounds to the Japanese market, and 2,464,000 pounds (canned) to European markets.

The average catch in covenanted waters during 1920 and 1921 was humpacks, 10,000,000; dog salmon, 2,000,000; and other salmon, 250,000. Figures from another source give the catch as follows:

Ichinsk and western Kamchatka districts

Year	Salmon					
	King		Keta		Humpback	
	Number	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*
1909	2, 626	24, 640	2, 378, 113	12, 275, 200	9, 704, 211	19, 479, 040
1910	400	4, 480	9, 012, 133	46, 513, 600	5, 449, 882	10, 937, 920
1911	5, 648	51, 520	3, 068, 565	15, 848, 000	40, 444, 172	81, 177, 600
1912	8, 647	78, 400	2, 804, 606	14, 474, 880	17, 979, 150	36, 086, 400
1913	5, 311	47, 040	4, 468, 331	23, 063, 040	27, 343, 537	54, 882, 240
Average	4, 526	40, 320	4, 346, 350	22, 435, 840	20, 184, 190	40, 512, 640
1914	1, 950	17, 920	4, 027, 819	20, 789, 440	57, 131, 118	114, 672, 320
1915	1, 330	11, 200	1, 039, 783	5, 367, 040	37, 590, 954	75, 492, 480
1916	922	8, 960	1, 386, 893	7, 159, 040	69, 143, 762	138, 783, 680
1917	1, 075	8, 960	3, 775, 583	19, 485, 760	87, 118, 213	174, 861, 120
1918	57, 742	495, 040	4, 103, 935	21, 181, 440	53, 778, 162	107, 941, 120
Average	12, 604	107, 520	2, 866, 803	14, 797, 440	60, 952, 442	122, 351, 040
1919	8, 763	78, 400	3, 429, 086	17, 698, 240	51, 003, 015	102, 401, 600
1920	10, 650	96, 320	6, 616, 818	34, 151, 040	61, 142, 739	125, 229, 440
1921	2, 401	22, 400	3, 651, 852	18, 847, 360	51, 040, 127	102, 446, 400
1922	575	4, 480	3, 455, 630	15, 998, 080	82, 880, 700	166, 756, 800
Average	5, 597	51, 520	4, 288, 347	21, 674, 240	61, 516, 645	124, 208, 000

Year	Salmon—Continued					
	Red		Silver		Total	
	Number	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*
1909			18, 380	94, 080	12, 103, 330	31, 872, 960
1910	1, 332, 152	6, 016, 640	21, 000	107, 520	15, 815, 567	63, 580, 160
1911	2, 217, 500	10, 015, 040	442, 393	2, 282, 560	46, 178, 278	109, 374, 720
1912	1, 299, 542	5, 859, 840	107, 662	555, 520	22, 199, 607	57, 055, 040
1913	1, 521, 276	6, 874, 560	101, 471	524, 160	33, 439, 926	85, 391, 040
Average	1, 274, 094	5, 752, 320	138, 181	712, 320	25, 947, 341	69, 453, 440
1914	572, 301	2, 584, 960	128, 352	663, 040	61, 861, 540	138, 727, 680
1915	2, 011, 889	9, 089, 920	180, 155	929, 600	40, 824, 111	90, 890, 240
1916	4, 486, 245	20, 260, 800	168, 375	869, 120	75, 186, 197	167, 081, 600
1917	2, 948, 855	13, 325, 760	308, 996	1, 594, 880	94, 152, 722	209, 276. 480
1918	2, 946, 667	13, 307, 840	318, 738	1, 644, 160	61, 205, 244	144, 569, 600
Average	2, 593, 191	11, 712, 960	220, 923	1, 140, 160	66, 645, 963	150, 109, 120
1919	3, 556, 437	16, 060, 800	534, 712	2, 761, 920	58, 532, 013	139, 000, 960
1920	5, 140, 304	23, 215, 360	485, 245	2, 506, 560	73, 395, 756	185, 198, 720
1921	1, 552, 285	7, 011, 200	259, 458	1, 339, 520	56, 506, 123	129, 666, 880
1922	4, 054, 722	18, 312, 000	91, 058	470, 400	90, 482, 685	201, 541, 760
Average	3, 575, 937	16, 150, 400	342, 618	1, 769, 600	69, 729, 144	163, 851, 520

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Ichinsk and western Kamchatka districts—Continued

Year	Herring		Miscellaneous		Grand total	
	Number	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*
1909			781, 038	2, 822, 400	12, 884, 368	34, 695, 360
1910			10, 000	35, 840	15, 825, 567	63, 616, 000
1911					46, 178, 278	109, 374, 720
1912			71, 963	259, 840	22, 271, 570	57, 314, 880
1913	100, 000	47, 040			33, 539, 926	85, 438, 080
Average	20, 000	8, 960	172, 600	622, 720	26, 139, 941	70, 085, 120
1914	34, 168	15, 680	400	2, 240	61, 896, 108	138, 745, 600
1915	63, 753	31, 360	117, 380	423, 360	41, 005, 244	91, 344, 960
1916	7, 609	4, 480	27, 613	100, 800	75, 221, 419	167, 186, 880
1917	8, 529	4, 480	116, 138	418, 880	94, 277, 389	209, 699, 840
1918	16, 273	6, 720	113, 328	409, 920	61, 334, 845	144, 986, 240
Average	26, 066	13, 440	74, 972	271, 040	66, 747, 001	150, 393, 600
1919	26, 302	13, 440	160, 229	577, 920	58, 718, 544	139, 592, 320
1920	298, 364	143, 360	66, 628	239, 680	73, 760, 748	185, 581, 760
1921	397, 006	190, 400	22, 845	82, 880	56, 925, 974	129, 940, 160
1922	98, 347	47, 040	18, 441	67, 200	90, 599, 473	201, 656, 000
Average	205, 005	98, 560	67, 036	241, 920	70, 001, 185	164, 192, 000

In 1913 canned goods were prepared by 12 canneries, which packed 45,400 cases. The canneries on the west Kamchatka coast were equipped with modern machinery and their pack went practically in its entirety to England. The refuse of canning and fishing was gathered, boiled, drained, and dried in ovens or in the sun, and thus turned into a fertilizer of high quality and value.

The production of Russian caviar was 127,680 pounds in 1909, 806,400 pounds in 1910, 1,568,000 pounds in 1911, 1,812,160 pounds in 1912, and 2,542,400 pounds in 1913.

EAST KAMCHATKA DISTRICT

The east Kamchatka district, comprising the eastern shore of Kamchatka Peninsula up to the Anadyr River, is over 1,800 miles long. Active fishing occupies only about 150 miles of the seacoast. A part of the seacoast around the Kamchatka River is closed to fishing. The number of fishing stations in this district was 38 in 1911, 54 in 1912, and 61 in 1913. The catch of salmon at these stations was as follows:

Year	Total	King	Chum	Humpback	Red	Silver
	Number	*Number*	*Number*	*Number*	*Number*	*Number*
1911	5, 688, 000	8, 000	3, 085, 000	1, 627, 000	750, 000	218, 000
1912	4, 934, 000	29, 000	3, 414, 000	497, 000	745, 000	249, 000
1913	9, 614, 000	30, 000	6, 464, 000	2, 623, 000	399, 000	98, 000

The output in 1910 was 27,328,000 pounds; in 1911, 25,536,000 pounds; in 1912, 25,760,000 pounds; and in 1913, 47,488,000 pounds. These figures do not include the output of river stations. In 1913 the number of salmon caught at river stations was 2,237,000 and of herring 100,000. Of this catch, 10,024,000 pounds of fish were prepared, as compared with 8,064,000 pounds in 1912 and 9,856,000 pounds in 1911. Of the total production of 57,568,000 pounds in

1913, 3,808,000 pounds of fish and 2,016,000 pounds of caviar were prepared for Russian markets, 47,712,000 pounds of dry-salted fish for Japanese markets, and 3,675,840 pounds of canned fish for European markets. Figures from another source show the following fish catch there:

Karaginsk and eastern Kamchatka

Year	Salmon					
	King		Keta		Humpback	
	Number	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*
1909			1,419,376	7,324,800	557,136	1,005,760
1910			1,584,261	8,176,000	1,180,416	2,132,480
1911	8,517	76,160	4,122,211	21,275,520	1,828,140	3,301,760
1912	21,889	197,120	4,234,818	21,857,920	571,804	1,032,640
1913	30,167	273,280	7,519,272	38,846,080	3,271,592	5,909,120
Average	12,115	109,760	3,775,988	19,496,960	1,481,818	2,676,800
1914	18,566	168,000	6,507,060	33,584,320	476,546	860,160
1915	26,341	237,440	3,796,227	19,593,280	5,030,995	9,087,680
1916	22,923	206,080	2,177,865	11,240,320	2,880,287	5,203,520
1917	38,249	344,960	2,791,192	14,405,440	3,852,289	6,959,680
1918	33,671	304,640	4,012,326	20,708,800	4,293,553	7,757,120
Average	27,950	253,120	3,856,934	19,906,880	3,306,734	5,974,080
1919	42,612	421,120	5,126,823	26,461,120	5,541,840	10,010,560
1920	66,157	598,080	4,232,519	21,844,480	5,877,866	10,617,600
1921	39,462	356,160	2,137,065	11,029,760	9,667,175	17,463,040
1922	74,265	669,760	2,251,325	11,603,200	253,949	459,200
Average	55,624	510,720	3,436,933	17,734,080	5,335,208	9,638,720

Year	Salmon—Continued					
	Red		Silver		Total	
	Number	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*
1909			5,646	29,120	1,982,158	8,359,680
1910	321,512	1,451,520			3,086,189	10,308,480
1911	1,021,176	4,614,400	243,675	1,256,640	7,223,719	30,524,480
1912	1,134,359	5,122,880	318,634	1,644,160	6,221,504	29,854,720
1913	859,701	3,801,280	152,823	788,480	11,833,555	49,618,240
Average	667,349	2,997,120	144,156	743,680	6,069,425	26,024,320
1914	952,707	4,303,040	238,012	1,227,520	8,192,891	40,143,040
1915	802,836	3,626,560	163,427	844,480	9,819,826	33,389,440
1916	1,611,212	7,275,520	467,792	2,414,720	7,160,079	26,340,160
1917	644,418	2,909,760	269,567	1,391,040	7,595,715	26,010,880
1918	1,113,755	5,147,520	368,639	1,901,760	9,847,944	35,819,840
Average	1,030,186	4,652,480	301,487	1,556,800	8,523,291	32,341,120
1919	3,231,378	14,593,600	1,029,478	5,313,280	14,972,131	56,799,680
1920	2,005,531	9,056,320	999,917	5,160,960	13,181,990	47,277,440
1921	1,404,521	6,343,680	291,515	1,505,280	13,539,738	36,697,920
1922	1,976,354	8,926,400	743,091	3,834,880	5,298,984	25,493,440
Average	2,154,446	9,730,560	766,000	3,953,600	11,748,211	41,567,680

Karaginsk and eastern Kamchatka—Continued

Year	Herring		Miscellaneous		Grand total	
	Number	*Pounds*	*Number*	*Pounds*	*Number*	*Pounds*
1909			394,779	1,426,880	2,376,937	9,786,560
1910					3,086,186	10,308,480
1911	25,000	11,200	8,956	31,360	7,257,675	30,567,040
1912	568,500	268,800	3,950	13,440	6,793,954	30,136,960
1913	88,740	42,560			11,922,295	49,660,800
Average	136,448	64,960	81,537	293,440	6,287,409	26,382,720
1914	795				8,193,686	40,143,040
1915	83,415	33,600	42,639	154,560	9,945,880	33,577,600
1916	425,428	206,080	85,546	309,120	7,671,053	26,855,360
1917	154,038	73,920	45,467	163,520	7,795,220	26,248,320
1918	51,522	24,640	68,394	246,400	9,967,860	36,090,880
Average	143,040	67,200	48,409	174,720	8,714,740	32,583,040
1919	335,962	161,280	74,667	268,800	15,382,760	57,229,760
1920	315,992	152,320	24,396	87,360	13,522,378	47,517,120
1921	3,030	2,240	30,255	109,760	13,573,023	36,809,920
1922	162,600	78,400	50,333	181,440	5,511,917	25,753,280
Average	204,396	98,560	44,913	161,280	11,997,520	41,827,520

The canning factories were located near the Kamchatka River, and their total pack in 1913 was 61,000 cases; in 1914, 71,660 cases; and in 1915, 104,000 cases.

The production of Russian caviar was 127,680 pounds in 1909, 790,720 pounds in 1910, 761,600 pounds in 1911, 967,680 pounds in 1912, and 2,011,520 pounds in 1913.

SAKHALIN DISTRICT

This district comprises the coast line of the Russian part of Sakhalin Island, excepting its western portion, which is included in the Nikolaevsk-on-Amur district and contains two bays reserved for Russian nationals only. The principal fishery in this region is for herring, salmon being of secondary importance. The catch of salmon and herring in this district was as follows:

Year	Dog salmon	Humpback	Total salmon	Herring
	Number	*Number*	*Number*	*Number*
1911	31,000	286,000	317,000	12,640,000
1912	16,000	126,000	142,000	14,036,000
1913	38,000	183,000	221,000	4,483,000

NOTE.—The poor catch in 1913 is attributed to the poor run of herring and also to storms. Practically the whole catch was exported to Japan.

OTHER WATERS

LENA-KOLYMA REGION

This region is of little importance as yet, owing to the sparsity of the population and lack of transportation facilities. Fish in this district were caught for local use only. With the establishment in 1911 of steamship lines from Kolyma to Vladivostok commercial

fishing began. The richest fishing grounds in the district are considered to be those in the lower reaches of the Lena River, the Aldan River and its tributaries, the Maya River, and the mouth of the Kolyma River. The catch in the Lena district is unknown. That of the Kolyma district (including lakes) reached 8,960,000 to 13,440,000 pounds, of which 896,000 pounds were shipped by steamers to the town of Yakutsk. The only market was the Lena mining district. The chief species are sturgeon, weighing sometimes as high as 200 pounds, muksun, nelma, gwiniad, chir, bass, pike, crucian, and carp.

LAKE BAIKAL REGION

This district includes Baikal Lake, rivers emptying into the lake (especially the Barguzin, Selenga, and upper Angara Rivers), and lagoonlike lakes ("sory") along the shores of Baikal Lake. The most important species of fish is the "omul" (*Coregonus baikalensis* or *C. migratorius*), which is taken the year round. Others are sturgeon, chir, gwiniad, grayling, crucian, burbot, and "golomiyanka" (*Comephorus baikalensis*). The latter lives in the deepest places of the lake and is about 10½ inches long. There are also found seals (*Phoca baikalensis*). In Frolikha Lake, near the northern extremity of Baikal Lake and communicating with the latter by a river of the same name, is found a special kind of trout (*Salvalinus erythrinus*) not known elsewhere.

Usually the fishermen are united into "artels" or gangs on a cooperative basis. The number of fishermen in the region was estimated at 2,500. The quantity of the catch is unknown.

YENISEI REGION

The Yenisei region is of very little commercial importance as yet. Fishing is done largely in the lower reaches of the Yenisei River and in small tundra lakes. The species caught are sturgeon, nelma, omul (*Coregonus autumnalis*), muksun, chir, seld (*Coregonus nerki*), and gwuiniad (*Coregonus pidschian*). The catch before the World War amounted to 13,440,000 pounds, of which half went to the markets, principally those of the towns of Yeniseisk and Krasnoyarsk. The fish were prepared with little regard to cleanliness and in a very primitive way, and had therefore a very bad odor. The inferior quality of the prepared fish and lack of communication restricted the sale of fish of this district to the Yenisei Province.

OB REGION

The Ob region was the most important in western Siberia. In Tobolsk Province the fishing industry is the mainstay for the major portion of the native tribes in this district. The largest number of fish was taken in the estuary of the Ob River, representing 40 per cent of all the fish shipped from this region. In the lower reaches of the Ob the catches were smaller, but a canning industry has begun to develop. The fish caught were river species and sea species ascending the Ob River for spawning. The most abundant are Cyprinidæ, salmonidæ, sturgeon, perch, cod, and pike.

In the middle and lower reaches of the Ob River and the lower part of the Irtysh River large quantities of fish perish, due to "zamor"—that is, impoverishment of river waters of oxygen, which may be attributed to thick ice cover and slow current. At this time the water assumes an unpleasant taste and smell. In places where the water is deep and the current rapid "zamor" does not occur.

The fish were either salted or dried and a small portion cured or canned. The fishing industry in this region is handicapped by poor transportation facilities. The total shipments of fish from this region before the World War averaged about 17,920,000 pounds, valued at $1,000,000. The chief markets are the towns of Tobolsk, Obdorsk, Berezov, Samarskoye, Surgut, and Narym.

BARABA REGION [9]

The Baraba region includes the Chana, Sartlana, Tanda, Ubi, and Karga Lakes, with a total water surface of 800,000 acres. The main fishing season is in winter. The fishermen number about 5,000, working in "artels" or gangs on a cooperative basis. This region has better transportation facilities, owing to the nearness of the Trans-Siberian Railroad. The catch, excluding that for local consumption, was valued at $500,000.

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The Japan Year Book, 1924–25, by Y. Takenobu. 718 pp. Tokyo.

[9] In the southern part of Tobolsk and Tomsk Provinces.

ALASKA FISHERY AND FUR-SEAL INDUSTRIES IN 1925[1]

By WARD T. BOWER, *Administrative Officer*

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[1] Appendix III to the Report of the United States Commissioner of Fisheries for 1926. B. F. Doc. 1008.

INTRODUCTION

The bureau's work in Alaska was conducted along the usual lines in the calendar year 1925. On the basis of the previous season's experience, some modifications were made in the regulations issued under authority of the new fisheries law of June 6, 1924, for the better protection and conservation of the salmon and other fisheries of Alaska. Larger appropriations enabled a considerable expansion of the fishery patrol during the season with resultant decrease in illegal fishing and better escapements of salmon. The Commissioner of Fisheries, accompanied by Representatives Wallace H. White and Arthur M. Free, and Lawrence Richey, spent about two months in Alaska for the purpose of observing conditions of the fishery industry and fur-seal operations on the Pribilof Islands.

The study of migration routes of salmon in southeastern Alaska and along the Alaska Peninsula was continued, and nearly 16,000 fish were tagged during the season. Weirs for the counting of salmon ascending streams to spawn were again operated in Chignik and Karluk Rivers and two streams tributary to Alitak Bay waters, and similar work was inaugurated at Anan Creek in southeastern Alaska. Studies of the salmon, clam, and herring fisheries were made by scientific assistants. Special attention was devoted to the marking of the mouths of salmon streams and also the marking of the limits of all closed waters.

On the Pribilof Islands a sufficient breeding reserve of 3-year-old male seals was marked as in the preceding season, a certain number being given a permanent brand. Approximately one-half of the sealskins taken on St. Paul Island were blubbered before being salted. The total take of sealskins on St. Paul Island was 15,082, and on St. George Island 4,778, a grand total of 19,860 skins.

Satisfactory progress was made at the Pribilof Islands in replacing dilapidated dwellings, thus providing more suitable quarters for white employees as well as natives. New waterworks plants on St. Paul and St. George Islands were put in operation. Road-construction work on St. Paul Island also progressed satisfactorily.

Foxing was carried on in the usual way and resulted in a take of 67 blue and 19 white pelts on St. Paul Island, and 638 blues and 1 white on St. George Island, a grand total of 725 skins, in the winter of 1925–26.

Two auction sales of fur-seal skins and one of fox skins were held during the year by the department's selling agents at St. Louis.

Acknowledgment is made of the great assistance rendered by members of the bureau's staff in the compilation and preparation of this document.

VISIT OF THE COMMISSIONER OF FISHERIES AND OTHER OFFICIALS TO ALASKA

The Commissioner of Fisheries and a party that included Congressmen Wallace H. White and Arthur M. Free, members of the Committee on the Merchant Marine and Fisheries, and Lawrence Richey,

of the Department of Commerce, spent a part of the summer of 1925 in Alaska inspecting fisheries in all districts and also visiting the Pribilof Islands. The party left South Bellingham, Wash., July 1, and stopped in southeastern Alaska for several days and at points along the Alaska Peninsula and in Bristol Bay en route to the Pribilof Islands, where July 18 and 19 were spent. Returning, the party spent several days in the central Alaska district, and a further stay was made in southeastern Alaska. Most of the party arrived in Seattle on August 29. The Coast and Geodetic Survey rendered valuable assistance by transporting the visitors through sections of Alaska where commercial steamers were not available.

Congressman Allen T. Treadway was in Alaska during the summer. He visited the southeastern and central districts and also made the overland trip to Fairbanks. Mr. Treadway exhibited great interest in the fisheries of the territory.

John P. Babcock, assistant to the Commissioner of Fisheries for British Columbia, and also chairman of the International Fisheries Commission, visited Alaska during the summer and accompanied Dr. C. H. Gilbert on a trip to salmon canneries along the Alaska Peninsula and to the Pribilof Islands in July.

FISHERY INDUSTRIES

As in corresponding reports for previous years, the Territory of Alaska is here considered in the three coastal geographic sections generally recognized, as follows: (1) Southeast Alaska, embracing all that narrow strip of mainland and the numerous adjacent islands from Portland Canal northwestward to and including Yakutat Bay; (2) central Alaska, the region on the Pacific from Yakutat Bay westward, including Prince William Sound, Cook Inlet, and the southern coast of Alaska Peninsula, to Unimak Pass; and (3) western Alaska, the north shore of the Alaska Peninsula, including the Aleutian Islands westward from Unimak Pass, Bristol Bay, and the Kuskokwim and Yukon Rivers. These divisions are solely for statistical purposes and do not coincide with areas established in departmental regulations.

Detailed reports and statistical tables dealing with the various fishery industries are presented herewith, and there are also given the important features of certain subjects that were the objects of special investigation or inquiry.

WATERS CLOSED TO COMMERCIAL FISHING

Under the act of June 6, 1924, previously issued Executive orders remained in effect in regard to the following waters: Afognak Reserve, Yes Bay and stream, Annette Island fishery reserve, and Aleutian Islands reservation. Under the regulations issued December 2, 1924, effective throughout the fishing season of 1925, commercial fishing was prohibited in 76 restricted areas in various parts of Alaska. Additional closures were imposed in regulations issued during the calendar year 1925.

NEW FISHERY REGULATIONS

The regulations for the protection of the fisheries of Alaska issued under date of December 2, 1924, were amended by the following regulations, issued under the dates indicated, by the Acting Secretary of Commerce:

[*January 28, 1925*]

KODIAK AREA

Herring fishery.—Regulation No. 1 is amended to read as follows:

"In the period from June 1 to October 1, both dates inclusive, commercial fishing for herring is prohibited in all waters closed throughout the year to salmon fishing."

COOK INLET AREA

Herring fishery.—Regulation No. 4 is amended to read as follows:

"In the period from June 1 to October 1, both dates inclusive, commercial fishing for herring is prohibited in all waters closed throughout the year to salmon fishing."

PRINCE WILLIAM SOUND AREA

Herring fishery.—Regulation No. 1 is amended to read as follows:

"Commercial fishing for herring is prohibited during the period from January 1 to June 24, both dates inclusive, and from November 16 to December 31, both dates inclusive, of each calendar year."

Regulation No. 3 is amended to read as follows:

"In the period from June 1 to October 1, both dates inclusive, commercial fishing for herring is prohibited in all waters closed throughout the year to salmon fishing."

SOUTHEASTERN ALASKA AREA

Herring fishery.—Regulation No. 1 is amended to read as follows:

"In the period from June 1 to October 1, both dates inclusive, commercial fishing for herring is prohibited in all waters closed throughout the year to salmon fishing. The waters of Kanalku Bay, Admiralty Island, are closed throughout the year to commercial fishing for herring."

Regulation No. 2 is amended to read as follows:

"Commercial fishing for herring is prohibited during the period from March 1 to April 30, both dates inclusive, of each calendar year, except that such fishing may be conducted from March 15 to April 15, both dates inclusive, in waters in the vicinity of Sitka within a line from Halibut Point to Cape Burunof."

[*February 17, 1925*]

REGULATIONS EFFECTIVE IN ALL AREAS

Salmon fishery.—The total aggregate length of gill nets on any salmon-fishing boat or used at any one time by any such boat shall not exceed 200 fathoms hung measure.

Clam fishery.—The minimum size of razor clams taken for commercial purposes is fixed at 4½ inches in total length of shell. Not more than 3 per cent in number of the clams taken may measure less than this minimum.

REGULATION EFFECTIVE IN KODIAK AREA

Salmon fishery.—All waters of Kiliuda Bay within a line drawn from Right Cape to Left Cape are closed to commercial fishing for salmon from January 1 to July 18, both dates inclusive, of each year.

REGULATION EFFECTIVE IN SOUTHEASTERN ALASKA AREA

Herring fishery.—Commercial fishing for herring is permitted during the period from March 1 to March 20, 1925, both dates inclusive, provided that during this period such fishing shall not be conducted on the actual spawning grounds of herring.

[*March 18, 1925*]

SOUTHEASTERN ALASKA AREA

Herring fishery.—Commercial fishing for herring is permitted during the period from March 21 to March 31, 1925, both dates inclusive, provided that during this period such fishing shall not be conducted on the actual spawning grounds of herring.

[*April 1, 1925*]

KODIAK AREA

Salmon fishery.—Regulation No. 4, extending the weekly closed period from 36 hours to 60 hours in waters inside of a line from Outlet Cape to Cape Uganik and to Miners Point, including Uganik Bay, Viekoda Bay, Terror Bay, and connecting and tributary waters, is hereby amended so that only the weekly closed period of 36 hours prescribed by law shall be effective in these waters.

Regulation No. 5, prohibiting commerical fishing for salmon in East Arm, Uganik Bay, within a line drawn from Mink Point to Rock Point, prior to July 21 in each calendar year, is hereby amended so that such fishing in these waters,

including the sand spit locally known as "The Packers Spit," is prohibited prior to 6 p. m., July 19, in each calendar year.

Regulation No. 9(c), prohibiting all commercial fishing for salmon in Kizhuyak Bay within a line from Kekur Point to Inner Point, is hereby amended to prohibit such fishing in these waters before 6 p. m., July 19, in each calendar year.

CHIGNIK AREA

Salmon fishery.—The use of floating traps for the capture of salmon is prohibited.

[*April 18, 1925*]

COPPER RIVER AREA

Salmon fishery.—The regulation extending the weekly closed period from 36 hours to 48 hours is hereby amended so that only the weekly closed period of 36 hours prescribed by law shall be effective.

Commercial fishing for salmon shall be conducted solely by drift gill nets not exceeding 250 fathoms in length each.

BERING RIVER AREA

Salmon fishery.—The regulation extending the weekly closed period from 36 hours to 48 hours is hereby amended so that only the weekly closed period of 36 hours prescribed by law shall be effective.

Commercial fishing for salmon shall be conducted solely by drift gill nets not exceeding 250 fathoms in length each.

[*April 25, 1925*]

STIKINE RIVER DISTRICT

Salmon fishery.—Regulation No. 2 is amended to read as follows:

"Commercial fishing for salmon, except by trolling, is prohibited in the period from June 21 to July 5, both dates inclusive."

Regulation No. 3 is amended to read as follows:

"Commercial fishing for salmon shall be conducted solely by trolling and by drift gill nets which shall not exceed 200 fathoms in length each."

[*June 8, 1925*]

COPPER RIVER AREA

Salmon fishery.—Fishing for salmon by means of gill nets attached to anchored boats or other anchored floating equipment is prohibited.

BERING RIVER AREA

Salmon fishery.—Fishing for salmon by means of gill nets attached to anchored boats or other anchored floating equipment is prohibited.

[*July 10, 1925*]

COPPER RIVER AREA

Salmon fishery.—Fishing for salmon on and after August 10 in each calendar year by means of stake nets generally out from the grass banks and not exceeding 350 fathoms each in length is permitted, provided that all stakes used in connection therewith shall be removed at or before the end of the fishing season.

On and after August 10 in each calendar year there will be no restrictions as to the amount of fishing apparatus used by each boat.

BERING RIVER AREA

Salmon fishery.—Fishing for salmon on and after August 10 in each calendar year by means of stake nets generally out from the grass banks and not exceeding 350 fathoms each in length is permitted, provided that all stakes used in connection therewith shall be removed at or before the end of the fishing season.

On and after August 10 in each calendar year there will be no restriction as to the amount of fishing apparatus used by each boat.

[*July 16, 1925*]

BRISTOL BAY AREA

Salmon fishery.—Commercial fishing for salmon is prohibited in the waters of the Bristol Bay area east of 158° west longitude from and after 6 o'clock p. m., July 16, 1925.

Commercial fishing for salmon in Nushagak Bay and tributary waters, including the waters off Etolin Point, is prohibited from and after 6 o'clock p. m., July 18, 1925.

[*July 30, 1925*]

KODIAK AREA

Salmon fishery.—Commercial fishing for salmon, except by beach seines on the north and east side of Horse Marine Bay, is prohibited inside of a line drawn in a northeasterly direction from Akhiok Village to the point on the east side of the entrance to Moser Bay during the remainder of the calendar year after July 30.

[*August 14, 1925*]

SOUTHEASTERN ALASKA AREA

Salmon fishery.—Commercial fishing for salmon in Lynn Canal, including Chilkat Inlet outside a line from Green Point and passing across the southern shore of Pyramid Island and including Chilkoot Inlet 500 yards outside the mouth of Chilkoot River, is permitted by gill nets only from September 5 to October 15, both dates inclusive.

[*August 18, 1925*]

RESURRECTION BAY AREA

Salmon fishery.—Commercial fishing for salmon within 1,000 yards from the mouths of Bear Creek and Resurrection River is prohibited.

[*August 19, 1925*]

STIKINE RIVER DISTRICT

Salmon fishery.—Regulation No. 3 is amended to read as follows:

"Commercial fishing for salmon shall be conducted solely by trolling and by drift gill nets, which shall not exceed 250 fathoms in length each."

[*August 20, 1925*]

RESURRECTION BAY AREA

Salmon fishery.—Regulation No. 1, extending the weekly closed period from 36 hours to 60 hours in the waters of Resurrection Bay within a line from Cape Resurrection to the western side of Bear Glacier at its mouth, is hereby amended so that only the weekly closed period of 36 hours prescribed by law shall be effective in these waters after August 25 of each year.

PRINCE WILLIAM SOUND AREA

Salmon fishery.—Regulation No. 1, extending the weekly closed period from 36 hours to 48 hours, is hereby amended so that only the weekly closed period of 36 hours prescribed by law shall be effective after August 25 of each year.

[*August 22, 1925*]

KODIAK AREA

Salmon fishery.—Subject to the 36-hour weekly closed period provided by law, all commercial fishing for salmon in Moser Bay is permitted during the remainder of each calendar year after August 22.

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Revised regulations covering the fisheries of Alaska were issued by the Secretary of Commerce under date of December 5, 1925, as follows:

By virtue of the authority vested in the Secretary of Commerce, fishing areas are hereby set apart and regulations governing fishing therein are made effective, as follows:

I. YUKON-KUSKOKWIM AREA

The Yukon-Kuskokwim area is hereby defined to include all territorial coastal and tributary waters of Alaska from Cape Newenham northward to the parallel of 64 degrees north latitude.

1. In the Yukon-Kuskokwim area all commercial fishing for salmon is prohibited at all times: *Provided*, That this prohibition shall not prevent the taking of fish for local food requirements or for use as dog feed.

II. BRISTOL BAY AREA

The Bristol Bay area is hereby defined to include all territorial coastal and tributary waters of Alaska extending from Cape Menshikof to Cape Newenham.

1. Commercial fishing for salmon shall be conducted solely by drift gill nets. The use of all other forms of fishing gear is prohibited.
2. The total aggregate length of gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 200 fathoms hung measure.
3. King salmon nets shall have a mesh at least 8½ inches stretched measure between knots, and red salmon nets shall have a mesh at least 5½ inches stretched measure between knots as measured when actually in use. No red salmon nets shall be over 28 meshes deep.
4. Prior to 6 o'clock antemeridian June 26 in each year commercial fishing for salmon with nets of mesh less than 8½ inches stretched measure between knots is prohibited.
5. Commercial fishing for salmon is prohibited during the remainder of each calendar year after 6 o'clock postmeridian July 25.
6. The trailing of web behind any fishing boat is prohibited above the markers fixing closed waters.
7. The use of motor-propelled fishing boats in catching salmon is prohibited.
8. The use of smelt nets is prohibited in localities where young salmon are migrating.
9. In the waters of Kvichak Bay between the line extending across the bay from the marker on a high point on the east bank of Prosper Creek, about 700 yards above the Koggiung cannery of the Alaska Packers Association, to the marker on the opposite side, the course being about north, 44 degrees west, magnetic, and the line extending across the bay from the marker at Graveyard Point, near the mouth of Graveyard Creek, to the marker on the opposite side between the mouths of Squaw and Russian Finn Creeks, the course being about north, 48 degrees west, magnetic, the 36-hour weekly closed period for salmon fishing prescribed by section 5 of the act of June 6, 1924, is hereby extended to include the period from 6 o'clock p. m. of Saturday of each week to 6 o'clock a. m. of the Tuesday following, making a weekly closed period of 60 hours.
10. All commercial fishing for salmon is prohibited as follows:

(*a*) Nushagak Bay: All waters north of 59 degrees north latitude.

(*b*) Kvichak Bay: All waters above a line extending at right angles across Kvichak Bay from the marker on a high point on the east bank of Prosper Creek, about 700 yards above the Koggiung cannery of the Alaska Packers Association, to the marker on the opposite side, the course being about north, 44 degrees west, magnetic.

(*c*) Ugashik River and Bay: All waters inside of a line from South Spit to the first beacon above the cannery of the Alaska Packers Association.

III. ALASKA PENINSULA AREA

The Alaska Peninsula area is hereby defined to include all territorial coastal and tributary waters of the Alaska Peninsula from Cape Menshikof on the Bering Sea shore and extending in a southwesterly direction to Unimak Pass, thence in a northeasterly direction along the Pacific side of the Alaska Peninsula to Castle Cape (Tuliumnit Point). The waters of Unimak, the Sanak, the Shumagin, and other adjacent islands are included.

Salmon fishery.—1. In the waters of Nelson Lagoon, and thence along the coast to Cape Seniavin, including Herendeen Bay, Port Moller, and the mouths of Bear and Sandy Rivers, the 36-hour closed period for salmon fishing prescribed by section 5 of the act of June 6, 1924, is hereby extended to include the period from 6 o'clock p. m. of Friday of each week to 6 o'clock a. m. of Tuesday of each week, making a weekly closed period in these waters of 84 hours, which shall be effective throughout the entire salmon fishing season of each year.

2. In all other waters of this area the 36-hour closed period for salmon fishing prescribed by section 5 of the act of June 6, 1924, is hereby extended to include the period from 6 o'clock p. m. of Friday of each week until 6 o'clock a. m. of the Monday following, making a weekly closed period of 60 hours: *Provided*, That this extension of 24 hours closed period each week shall not be effective after midnight of July 25 each year.

3. The total aggregate length of gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 200 fathoms hung measure.

4. The use of floating traps for the capture of salmon is prohibited.

5. With the exception of Unga Island, in the waters of which trap fishing for salmon is permitted, the use of traps for the capture of salmon is prohibited in the waters of the Shumagin Islands, the Sanak Islands, and all other islands lying between or adjacent to these two groups.

6. In all waters along the shores of the Alaska Peninsula west of the longitude of Cape Aliaksin, and in the waters of Unga Island, all traps for the capture of salmon shall be at least 1 statute mile apart laterally.

7. The use of any trap for the capture of salmon is prohibited in the waters of False Pass (Isanotski Strait) within lines determined by markers erected for that purpose.

8. The use of purse seines for the capture of salmon is prohibited, except that (*a*) in the waters of the Shumagin Islands seines not to exceed 100 fathoms in length and 150 meshes in depth may be used, and (*b*) purse seines are permitted in waters open to commercial fishing between Lagoon Point and Cape Seniavin.

9. In Port Heiden waters the catch of red salmon shall not exceed 35,000 in any calendar year.

10. All commercial fishing for salmon is prohibited, as follows:

(*a*) Within 1 statute mile of the mouths of Bear and Sandy Rivers.

(*b*) Morzhovoi Bay: All waters within the bay east of 163 degrees 5 minutes west longitude.

(*c*) Thin Point Lagoon: All waters within the lagoon and its stream and within a distance of 500 yards outside the entrance to the lagoon.

(*d*) Cold Bay: All waters of the bay within a line extending from the eastern extremity of Thin Point to a point at 55 degrees 2 minutes north latitude and 162 degrees 25 minutes west longitude.

(*e*) Stepovak Bay and Balboa Bay: All waters of these bays and of their branches and arms, excepting Orzinski (Orzenoi) Bay, within a line from the outer extremity of Kupreanof Point to the outer extremity of Cape Aliaksin. In Orzinski (Orzenoi) Bay beach seines only may be used, and the catch of red salmon shall not exceed 25,000 in any calendar year.

(*f*) All waters between Kupreanof Point and Cape Ikti.

Clam fishery.—It is prohibited to take for commercial purposes any razor clam measuring less than 4½ inches in total length of shell. Possession of any razor clam of less than this length will be regarded as prima facie evidence of unlawful taking.

IV. ALEUTIAN ISLANDS AREA

The Aleutian Islands area is hereby defined to include all territorial coastal and tributary waters of the Aleutian Islands westward of and including Unimak Pass.

1. The total aggregate length of gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 200 fathoms hung measure.

2. Commercial fishing for salmon is prohibited during the period from 6 o'clock p. m. August 20 to 6 o'clock p. m. October 1 in each year.

3. The use of traps and purse seines for the capture of salmon is prohibited.

V. CHIGNIK AREA

The Chignik area is hereby defined to include the territorial coastal and tributary waters of Alaska along the mainland shore from Castle Cape (Tuliumnit Point) to Cape Kumnik.

Salmon fishery.—1. The use of purse seines and floating traps for the capture of salmon is prohibited.

2. The total aggregate length of gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 200 fathoms hung measure.

3. The take of salmon within Chignik waters shall not exceed 50 per cent of the total run as determined at the weir in Chignik River operated by the Bureau of Fisheries.

4. Commercial fishing for salmon is prohibited prior to 6 o'clock a. m. June 15 and after 6 o'clock p. m. September 15 in each year.

5. Commercial fishing for salmon is prohibited in the waters surrounding Nakchamik and Chankliut Islands.

Clam fishery.—It is prohibited to take for commercial purposes any razor clam measuring less than 4½ inches in total length of shell. Possession of any razor clam of less than this length will be regarded as prima facie evidence of unlawful taking.

VI. KODIAK AREA

The Kodiak area is hereby defined to include the waters of the mainland shore extending from Cape Douglas southwestward to Cape Kumnik and the territorial coastal and tributary waters of Alaska surrounding Kodiak and adjacent islands, but excluding the waters embraced within the Afognak forest and fish culture reserve established by presidential proclamation of December 24, 1892.

Salmon fishery.—1. The use of purse seines and floating traps for the capture of salmon is prohibited.

2. The total aggregate length of gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 200 fathoms hung measure.

3. Commercial fishing for salmon in Alitak Bay and all its branches within a line from Cape Trinity to Cape Alitak prior to 6 o'clock a. m. June 15 in each year is prohibited.

4. Commercial fishing for salmon within a line from Cape Trinity to Cape Alitak shall be conducted solely by beach seines and traps, but no fishing for salmon shall be permitted inside a line from Bun Point through Turn Island at the entrance of Moser Bay to Akhiok village.

5. The take of salmon within waters in which the runs are tributary to Olga Bay shall not exceed 50 per cent of the total run as determined at the weirs on tributary waters of Olga Bay operated by the Bureau of Fisheries.

6. Commercial fishing for salmon in Karluk waters, extending from Cape Karluk to Cape Kuliuk, prior to 6 o'clock a. m. June 15 and after 6 o'clock p. m. September 15 in each year is prohibited. The take of salmon in these waters shall not exceed 50 per cent of the total run as determined at the weir in Karluk River operated by the Bureau of Fisheries.

7. All commercial fishing for salmon between Cape Uyak and Cape Karluk except by beach seines is prohibited.

8. Commercial fishing for salmon in East Arm, Uganik Bay, within a line from Mink Point to Rock Point and including the sand spit locally known as "The Packers Spit," is prohibited prior to 6 o'clock a. m. July 21 in each calendar year.

9. Commercial fishing for salmon in all waters of Kizhuyak Bay within a line from Kekur Point to Inner Point is prohibited prior to 6 o'clock a. m. July 21 in each calendar year.

10. Commercial fishing for salmon in all waters of Kiliuda Bay within a line from Right Cape to Left Cape is prohibited prior to 6 o'clock a. m. July 21 in each calendar year.

11. All commercial fishing for salmon is prohibited, as follows:

(*a*) Western shore of Kodiak Island: All waters along the western shore of Kodiak Island between Cape Alitak and Cape Karluk.

(*b*) Karluk River: All waters within Karluk River and within 100 yards of its mouth where it breaks through Karluk Spit into Shelikof Strait.

(*c*) Kaflia Bay, on north shore of Shelikof Strait: All waters within a line from Cape Ugyak to Cape Gull.

(*d*) Eagle Harbor, in Ugak Bay, southeastern shore of Kodiak Island: All waters within the harbor.

Herring fishery.—1. Commercial fishing for herring is prohibited during the period from January 1 to July 14, both dates inclusive, and from October 15 to December 31, both dates inclusive, in each calendar year.

2. During the period from July 15 to October 1, both dates inclusive, commercial fishing for herring is prohibited in all waters closed throughout the year to salmon fishing.

3. The closed season herein specified for herring fishing shall not apply to any boat taking not to exceed 60 barrels of herring in any calendar week in waters otherwise open to fishing.

4. Gill nets used in catching herring shall not be of smaller mesh than 3 inches stretched measure.

5. No one shall place, or cause to be placed, across the entrance of any lagoon or bay any net or other device which will prevent the free passage at all times of herring in and out of said lagoon or bay.

Clam fishery.—It is prohibited to take for commercial purposes any razor clam measuring less than 4½ inches in total length of shell. Possession of any razor clam of less than this length will be regarded as prima facie evidence of unlawful taking.

VII. COOK INLET AREA

The Cook Inlet area is hereby defined to include Cook Inlet, its tributary waters, and all adjoining waters north of Cape Douglas and west of Point Gore. The Barren Islands are included within this area.

Salmon fishery.—1. Commercial fishing for salmon is prohibited from 6 o'clock p. m. August 10 to 6 o'clock a. m. August 25, and for the remainder of each year after 6 o'clock p. m. September 30.

2. The use of purse seines and floating traps for the capture of salmon is prohibited.

3. The total aggregate length of gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 200 fathoms hung measure.

4. Commercial fishing for salmon is prohibited within 1 statute mile of all salmon streams except in respect to the Kasilof and Kenai Rivers, where commercial fishing for salmon is prohibited within 2 statute miles of their mouths.

5. Commercial fishing for salmon is prohibited above a line from Point Possession to the western limit of the closed area around the mouth of the Susitna River.

6. Commercial fishing for salmon is prohibited in Chinik Inlet, Kamishak Bay.

7. Commercial fishing for salmon is prohibited in Kachemak Bay above a line from Indian Island to a point on the opposite shore one-half mile below the mouth of Swift Creek.

Herring fishery.—1. Commercial fishing for herring is prohibited during the period from January 1 to July 14, both dates inclusive, and from October 15 to December 31, both dates inclusive, in each calendar year: *Provided*, That fishing for herring in Halibut Cove and Lagoon is permitted during the period from October 15 to December 31.

2. During the period from July 15 to October 1, both dates inclusive, commercial fishing for herring is prohibited in all waters closed throughout the year to salmon fishing.

3. Commercial fishing for herring in Halibut Cove and Lagoon, including the waters within a line from the light on Ismailof Island to the outermost point on Glacier Spit, is limited to gill nets.

4. The closed season herein specified for herring fishing shall not apply to any boat taking not to exceed 60 barrels of herring in any calendar week in waters otherwise open to fishing.

5. The maintaining of a herring pound or the dumping of offal and dead herring in the waters of Halibut Cove and Lagoon is prohibited.

6. Gill nets used in catching herring shall not be of smaller mesh than 3 inches stretched measure.

7. No one shall place, or cause to be placed, across the entrance of any lagoon or bay any net or other device which will prevent the free passage at all times of herring in and out of said lagoon or bay.

Clam fishery.—It is prohibited to take for commercial purposes any razor clam measuring less than 4½ inches in total length of shell. Possession of any razor clam of less than this length will be regarded as prima facie evidence of unlawful taking.

VIII. RESURRECTION BAY AREA

The Resurrection Bay area is hereby defined to include all territorial coastal and tributary waters of the Gulf of Alaska between Point Gore on the west and Cape Fairfield on the east.

Salmon fishery.—1. The total aggregate length of gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 200 fathoms hung measure.

2. In the waters of Resurrection Bay, within a line from Cape Resurrection to the western side of Bear Glacier at its mouth, the 36-hour closed period for salmon

fishing prescribed by section 5 of the act of June 6, 1924, is hereby extended to include the period from 6 o'clock p. m. of Friday of each week until 6 o'clock a. m. of the Monday following, making a weekly closed period of 60 hours: *Provided*, That this extension shall not be effective after August 25 in each year.

3. Commercial fishing for salmon within 1,700 yards of the mouths of Bear Creek and Resurrection River is prohibited.

Clam fishery.—It is prohibited to take for commercial purposes any razor clam measuring less than 4½ inches in total length of shell. Possession of any razor clam of less than this length will be regarded as prima facie evidence of unlawful taking.

IX. PRINCE WILLIAM SOUND AREA

The Prince William Sound area is hereby defined to include all territorial coastal and tributary waters of the Gulf of Alaska between Cape Fairfield on the west and Point Whitshed on the east.

Salmon fishery.—1. The total aggregate length of gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 200 fathoms hung measure.

2. No salmon fishing boat shall carry or operate more than one seine of any description, and no additional net of any kind shall be carried on such boat. No purse seine shall be less than 100 meshes nor more than 150 meshes in depth, nor less than 75 fathoms nor more than 125 fathoms in length measured on the cork line. For the purpose of determining depths of seines, measurements will be upon the basis of 3½ inches stretched measure between knots. No extension to any seine in the way of leads will be permitted.

3. All set or anchored gill nets shall not exceed 200 yards each in length and shall be placed in substantially a straight line: *Provided*, That not to exceed 20 yards of each net may be used as a hook. Only one such hook is permitted on a net. There shall be a distance interval of at least 200 yards both endwise and laterally at all times between all set or anchored gill nets operated.

4. The use of traps for the capture of salmon is prohibited in all waters along the coast from the outer point on the north shore of Granite Bay to the light on the south shore of the entrance to Port Nellie Juan.

5. The 36-hour closed period for salmon fishing prescribed by section 5 of the act of June 6, 1924, is hereby extended to include the period from 6 o'clock a. m. of Saturday of each week until 6 o'clock a. m. of the Monday following, making a weekly closed period of 48 hours: *Provided*, That this extension shall not be effective after August 25 in each year.

6. Commercial fishing for salmon is prohibited from 6 o'clock p. m. August 9 to 6 o'clock p. m. August 25 in each year.

7. All traps operated in the Prince William Sound area shall be at least 1½ statute miles apart laterally.

8. All commercial fishing for salmon is prohibited, as follows:

(*a*) Constantine Harbor: All waters above a line at right angles across the harbor at prominent shore-line points about 1¼ statute miles from the mouth of the large salmon stream flowing into the northeast arm of the harbor.

(*b*) Port Etches: All waters within 1 statute mile of the mouth of the salmon stream flowing into the head of Port Etches.

(*c*) Boswell Bay, indenting Hinchinbrook Island: All waters in the bay west of 146° 8′ west longitude.

(*d*) Twin Lake Creek: All waters within 1,000 yards of the mouth of Twin Lake Creek flowing into the southeast arm of Simpson Bay.

(*e*) Port Fidalgo: All waters east of 146° 20′ west longitude.

(*f*) Robe River, Lowe River, and other unnamed streams flowing into Port Valdez in the immediate vicinity of Valdez: All waters within 1,000 yards of the mouths.

(*g*) Billy's Hole, tributary to Long Bay, between Valdez Arm and Unakwik Inlet: All waters within a line from Point Scott to Point Hook and passing just westward of Observation Island.

(*h*) Unakwik Inlet, indenting mainland on north shore of Prince William Sound: All waters within the eastern half of the inlet north of an east and west line passing through the northern side of the entrance to Jonah Bay.

(*i*) Coghill River, tributary to College Fiord: All waters within 2,000 yards outside of the mouth of the river.

(*j*) Long Bay, tributary to Culross Passage: All waters within the bay.

(*k*) Gumboot Creek, on northwest shore of Eshamy Bay: All waters within 1,000 yards of the mouth of the creek.

(*l*) Eshamy Lagoon and its tributary waters: All waters within the lagoon and its tributaries and within 100 yards outside the narrows at the entrance to the lagoon.

(*m*) Jackpot Bay: All waters within a line extending at right angles across its mouth 2,000 yards below the mouth of the red salmon stream emptying into the bay.

(*n*) Port Bainbridge: All waters in the middle north arm of Port Bainbridge.

(*o*) Bay of Isles, indenting east shore of Knight Island: All waters within the west arm of the bay.

Herring fishery.—1. Commercial fishing for herring is prohibited during the period from January 1 to June 24, both dates inclusive, and from November 16 to December 31, both dates inclusive, of each calendar year.

2. The closed seasons herein specified for herring fishing shall not apply to any boat taking not to exceed 60 barrels of herring in any calendar week in waters open to fishing.

3. During the period from June 25 to October 1, both dates inclusive, commercial fishing for herring is prohibited in all waters closed throughout the year to salmon fishing.

4. Gill nets used in catching herring shall not be of smaller mesh than 2¼ inches stretched measure.

5. No one shall place, or cause to be placed, across the entrance of any lagoon or bay any net or other device which will prevent the free passage at all times of herring in and out of said lagoon or bay.

Clam fishery.—1. It is prohibited to take for commercial purposes any razor clam measuring less than 4½ inches in total length of shell. Possession of any razor clam of less than this length will be regarded as prima facie evidence of unlawful taking.

2. The taking of clams for commercial purposes is prohibited from 6 o'clock p. m. July 15 to 6 o'clock p. m. August 31 in each calendar year.

X. COPPER RIVER AREA

The Copper River area is hereby defined to include all territorial coastal and tributary waters of Alaska between Point Whitshed on the west and Point Martin on the east, including Egg Islands and the other islands between these points.

Salmon fishery.—1. Commercial fishing for salmon is prohibited from 6 o'clock p. m. July 10 to 6 o'clock a. m. August 10 in each year.

2. Prior to 6 o'clock a. m. May 20 in each year commercial fishing with nets of mesh less than 8½ inches stretched measure between knots is prohibited.

3. From May 20 to July 10, both dates inclusive, the 36-hour closed period for salmon fishing prescribed by section 5 of the act of June 6, 1924, is hereby extended to include the period from 6 o'clock a. m. of Saturday of each week until 6 o'clock a. m. of the Monday following, making a weekly closed period of 48 hours.

4. Except as specifically permitted herein, commercial fishing for salmon shall be conducted solely by drift gill nets.

5. Prior to 6 o'clock a. m. August 10 in each calendar year the total aggregate length of drift gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 250 fathoms hung measure: *Provided*, That during the period from 6 o'clock a. m. May 20 to 6 o'clock p. m. May 31 any gill net boat on the Copper River flats may carry and operate not to exceed 100 fathoms of net of mesh not less than 8½ inches stretched measure between knots in addition to 250 fathoms of smaller mesh net.

6. Prior to 6 o'clock a. m. August 10 in each calendar year commerical fishing for salmon by means of gill nets attached to anchored boats or other anchored floating equipment is prohibited.

7. Commercial fishing for salmon is prohibited within 500 yards of the Grass Banks, except that after 6 o'clock a. m. August 10 in each calendar year such fishing is permitted within 500 yards of the Grass Banks by means of gill nets and stake nets not exceeding 350 fathoms each in length: *Provided*, That all stakes used in connection therewith shall be removed at or before the end of the fishing season. All fishing is prohibited at all times within the sloughs and within 500 yards of their mouths.

Clam fishery.—It is prohibited to take for commercial purposes any razor clam measuring less than 4½ inches in total length of shell. Possession of any razor clam of less than this length will be regarded as prima facie evidence of unlawful taking.

XI. BERING RIVER AREA

The Bering River area is hereby defined to include all territorial coastal and tributary waters of Alaska between Point Martin on the west and Cape Suckling on the east.

Salmon fishery.—1. Commercial fishing for salmon is prohibited from 6 o'clock p. m. July 10 to 6 o'clock a. m. August 10 in each year.

2. Prior to 6 o'clock a. m. June 1 in each year commercial fishing with nets of mesh less than 8½ inches stretched measure between knots is prohibited.

3. From June 1 to July 10, both dates inclusive, the 36-hour closed period for salmon fishing prescribed by section 5 of the act of June 6, 1924, is hereby extended to include the period from 6 o'clock a. m. of Saturday of each week until 6 o'clock a. m. of the Monday following, making a weekly closed period of 48 hours.

4. Except as specifically permitted herein, commercial fishing for salmon shall be conducted solely by drift gill nets.

5. Prior to 6 o'clock a. m. August 10 in each calendar year the total aggregate length of drift gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 250 fathoms hung measure.

6. Prior to 6 o'clock a. m. August 10 in each calendar year commercial fishing for salmon by means of gill nets attached to anchored boats or other anchored floating equipment is prohibited.

7. After 6 o'clock a. m. August 10 in each calendar year commercial fishing for salmon is permitted by means of gill nets and stake nets not exceeding 350 fathoms each in length: *Provided*, That all stakes used in connection therewith shall be removed at or before the end of the fishing season.

Clam fishery.—It is prohibited to take for commercial purposes any razor clam measuring less than 4½ inches in total length of shell. Possession of any razor clam of less than this length will be regarded as prima facie evidence of unlawful taking.

XII. SOUTHEASTERN ALASKA AREA

The southeastern Alaska area is hereby defined to include all territorial coastal and tributary waters of Alaska extending from Dixon Entrance on the south to and including Yakutat Bay on the north.

Salmon fishery.—This area is subdivided into the following districts, wherein regulations shall be effective as follows:

Yakutat district.—All waters of this area west of the one hundred and thirty-eighth meridian of west longitude.

1. The total aggregate length of gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 200 fathoms hung measure.

2. All traps shall be at least 1½ statute miles apart laterally.

3. No salmon fishing boat shall carry or operate more than one seine of any description, and no additional net of any kind shall be carried on such boat. No purse seine shall be less than 200 meshes nor more than 300 meshes in depth, nor less than 150 fathoms nor more than 250 fathoms in length measured on the cork line. For the purpose of determining depths of seines, measurements will be upon the basis of 3½ inches stretched measure between knots. No extension to any seine in the way of leads will be permitted.

4. The 36-hour closed period for salmon fishing prescribed by section 5 of the act of June 6, 1924, is hereby extended to include the period from 6 o'clock a. m. of Saturday of each week until 6 o'clock a. m. of the Monday following, making a weekly closed period of 48 hours.

5. Commercial fishing for salmon is prohibited during the period from 6 o'clock p. m. July 20 to 6 o'clock p. m. August 5 in each year.

6. All commercial fishing for salmon is prohibited, as follows:

(*a*) Ankau Creek and Inlet.

(*b*) Akwe or Ahquay River.

(*c*) The "Basin" above Dry Bay.

Icy Strait-Cross Sound district.—All waters of this area north of the fifty-eighth parallel of north latitude and east of the one hundred and thirty-eighth meridian of west longitude.

1. The total aggregate length of gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 200 fathoms hung measure.

2. All traps shall be at least 1½ statute miles apart laterally.

3. Traps and purse seines are prohibited in Lynn Canal and contiguous waters north of 58° 26′ north latitude.

4. No salmon fishing boat shall carry or operate more than one seine of any description, and no additional net of any kind shall be carried on such boat.

No purse seine shall be less than 200 meshes nor more than 300 meshes in depth, nor less than 150 fathoms nor more than 250 fathoms in length measured on the cork line. For the purpose of determining depths of seines, measurements will be upon the basis of 3½ inches stretched measure between knots. No extension to any seine in the way of leads will be permitted.

5. Commercial fishing for salmon is prohibited for the remainder of each calendar year after 6 o'clock p. m. August 6, except that such fishing may be carried on (*a*) by trolling, and (*b*) by gill nets from 6 o'clock a. m. September 5 to 6 o'clock p. m. October 15 in waters open to fishing.

6. Commercial fishing for salmon in Lynn Canal and contiguous waters north of the south end of Kochu Island is prohibited, except that in these closed waters, including Chilkat Inlet outside of a line from Green Point, passing across the southern shore of Pyramid Island and Chilkoot Inlet 1,000 yards outside the mouth of Chilkoot River, such fishing is permitted by gill nets from 6 o'clock a. m. September 5 to 6 o'clock p. m. October 15 in each year.

7. Commercial fishing for salmon, except by gill nets, is prohibited in Dundas Bay north of 58° 21′ north latitude.

8. All commercial fishing for salmon is prohibited, as follows:

(*a*) Port Frederick, northern shore of Chichagof Island: All waters east of a line from Inner Point Sophia to Game Point and all waters south of 58° 4′ north latitude. A portion of the waters closed is in the central district.

(*b*) Glacier Bay: All waters within a line from Point Carolus to Point Gustavus.

(*c*) Taku Inlet: All waters to the eastward of a line beginning on the shore northward of Taku Point at 133° 59′ west longitude, thence running due north to the opposite shore, thence following the shore line to the mouth of the Taku River.

Central district.—All waters of this area between the fifty-seventh and fifty-eighth parallels of north latitude.

1. The total aggregate length of gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 200 fathoms hung measure.

2. All traps shall be at least 1 statute mile apart laterally.

3. No salmon fishing boat shall carry or operate more than one seine of any description, and no additional net of any kind shall be carried on such boat. No purse seine shall be less than 200 meshes nor more than 300 meshes in depth nor less than 150 fathoms nor more than 250 fathoms in length measured on the cork line. For the purpose of determining depths of seines, measurements will be upon the basis of 3½ inches stretched measure between knots. No extension to any seine in the way of leads will be permitted.

4. Commercial fishing for salmon, except by trolling, is prohibited for the remainder of each year after 6 o'clock p. m. August 11.

5. All commercial fishing for salmon is prohibited, as follows:

(*a*) Port Houghton, indenting mainland: All waters in Sanborn Canal.

(*b*) Portage Bay, north end of Kupreanof Island: All waters within the bay and all waters within 1 statute mile outside the entrance to the bay. A portion of the waters closed is in the southern district.

(*c*) Gambier Bay, east coast of Admiralty Island: All waters west of 134° west longitude.

(*d*) Wilson Cove, southwestern shore of Admiralty Island: All waters within the cove.

(*e*) Whitewater Bay, southwestern shore of Admiralty Island: All waters within a line from Point Caution to Woody Point.

(*f*) Chaik Bay, southwestern shore of Admiralty Island: All waters east of 134° 29′ west longitude.

(*g*) Warm Spring Bay, eastern shore of Baranof Island: All waters within the bay.

(*h*) Kelp Bay, east coast of Baranof Island: All waters in Middle Arm, and all waters in South Arm west of 134° 57′ west longitude.

(*i*) Hanus Bay, northeast shore of Baranof Island: All waters in the bay south of a line from Point Hanus to Point Moses.

(*j*) Sitkoh Bay, southeast shore of Chichagof Island: All waters within 1,000 yards of the mouths of all salmon streams.

(*k*) Basket Bay, east coast of Chichagof Island: All waters within the bay.

(*l*) Tenakee Inlet and Freshwater Bay: All waters within a line from North Passage Point to South Passage Point.

Stikine River district.—All waters within a line from Babbler Point on the mainland to Woronkofski Point on Woronkofski Island, thence to Middle Craig Point on Zarembo Island, thence to Point Howe on Mitkof Island, thence to

Frederick Point on Mitkof Island, thence across Frederick Sound to Horn Cliffs on the mainland, thence along the mainland to Babbler Point.

1. Commercial fishing for salmon shall be conducted solely by trolling and by drift gill nets which shall not exceed 250 fathoms in length each.

2. Commercial fishing for salmon, except by trolling, is prohibited during the period from 6 o'clock p. m. June 10 to 6 o'clock p. m. June 30 in each year.

3. The 36-hour closed period for salmon fishing prescribed by section 5 of the act approved June 6, 1924, is hereby extended to include the period from 6 o'clock a. m. of Saturday of each week to 6 o'clock a. m. of the Monday following, making a weekly closed period of 48 hours.

Prince of Wales Island district.—All waters of the west coast of Prince of Wales Island and adjacent islands from Cape Chacon northward to Point Baker, and within a line from Point Baker to Pine Point, thence along the shore line to Point Colpoys, thence to Middle Craig Point on Zarembo Island, thence to Woronkofski Point on Woronkofski Island, thence to Babbler Point on the mainland, thence to Watkins Point on Cleveland Peninsula, thence following the watershed between Ernest Sound and Behm Canal to and including Lemesurier Point, thence to Tolstoi Point on Prince of Wales Island, thence following the watershed on Prince of Wales Island to Cape Chacon.

1. The total aggregate length of gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 200 fathoms hung measure.

2. All traps shall be at least 1 statute mile apart laterally.

3. No salmon fishing boat shall carry or operate more than one seine of any description, and no additional net of any kind shall be carried on such boat. No purse seine shall be less than 200 meshes nor more than 300 meshes in depth, nor less than 150 fathoms nor more than 250 fathoms in length measured on the cork line. For the purpose of determining depths of seines measurements will be upon the basis of 3½ inches stretched measure between knots. No extension to any seine in the way of leads will be permitted.

4. Commercial fishing for salmon, except by trolling, is prohibited from 6 o'clock p. m. August 22 to 6 o'clock p. m. September 14 in each year, and for the remainder of each year after 6 o'clock p. m. October 15; and in addition commercial fishing for salmon, except by trolling, is prohibited in all waters of the west coast of Prince of Wales Island and adjacent islands from Cape Chacon northward to Point Baker from January 1 to 6 o'clock p. m. July 14 in each year.

5. All commercial fishing for salmon is prohibited, as follows:

(*a*) Thorne and Tolstoi Bays, indenting the eastern shore of Prince of Wales Island: All waters within a line from Tolstoi Point to Thorne Head.

(*b*) McHenry Inlet, southwest coast of Etolin Island: All waters within 1,000 yards of the salmon streams emptying into the head of McHenry Inlet.

(*c*) Thoms Place, indenting the southwestern shore of Wrangell Island, Zimovia Strait.

(*d*) Olive Cove, indenting the northeastern shore of Etolin Island.

(*e*) Anita Bay, opening into Zimovia Strait, Etolin Island.

(*f*) Barnes Lake, at head of Lake Bay, northeast coast of Prince of Wales Island: All waters in Barnes Lake and within 50 yards outside its entrance.

(*g*) Whale Passage, northeast coast of Prince of Wales Island: All waters within 1,000 yards from mouths of all salmon streams.

(*h*) Salmon Bay, northeast shore of Prince of Wales Island: All waters within the bay.

(*i*) Red Bay, north shore of Prince of Wales Island: All waters south of a true east and west line passing through the north shore of Dead Island.

(*j*) Shipley Bay, west coast of Kosciusko Island: All waters east of 133 degrees 32 minutes 30 seconds west longitude.

(*k*) Sarkar Cove, west coast of Prince of Wales Island, tributary to El Capitan Passage: All waters inside of a line across the entrance.

(*l*) Naukati Bay, west coast of Prince of Wales Island: All waters within the bay.

(*m*) Trocadero Bay, west coast of Prince of Wales Island: All waters in the bay east of a true north and south line passing through the eastern extremity of the peninsula just south of Copper Mine.

(*n*) North Bay, northeast coast of Dall Island: All waters within 1,000 yards of the mouths of all salmon streams.

(*o*) Kasook Inlet, southern coast of Sukkwan Island: All waters within 1 statute mile of head of inlet.

(*p*) Hetta Inlet, west coast of Prince of Wales Island: All waters north of a line running east, magnetic, from Eek Point to the opposite shore.

Southern district.—All waters south of the fifty-seventh parallel of north latitude, exclusive of the Stikine River and Prince of Wales Island districts herein described.

1. The total aggregate length of gill nets on any salmon fishing boat, or in use by such boat, shall not exceed 200 fathoms hung measure.

2. All traps shall be at least 1 statute mile apart laterally.

3. No salmon fishing boat shall carry or operate more than one seine of any description, and no additional net of any kind shall be carried on such boat. No purse seine shall be less than 200 meshes nor more than 300 meshes in depth, nor less than 150 fathoms nor more than 250 fathoms in length measured on the cork line. For the purpose of determining depths of seines measurements will be upon the basis of 3½ inches stretched measure between knots. No extension to any seine in the way of leads will be permitted.

4. Commercial fishing for salmon, except by trolling, is prohibited from 6 o'clock p. m., August 18, to 6 o'clock p. m., September 14 in each year, and for the remainder of each calendar year after 6 o'clock p. m. October 15.

5. All commercial fishing for salmon is prohibited, as follows:

(*a*) Hidden Inlet, indenting mainland: All waters in the inlet north of 55 degrees north latitude.

(*b*) Ray Anchorage, east coast of Duke Island: All waters in Ray Anchorage.

(*c*) Very Inlet, indenting mainland: All waters within the inlet.

(*d*) Boca de Quadra, indenting mainland: All waters within 1 statute mile of the mouth of Sockeye Creek.

(*e*) George Inlet, southern coast of Revillagigedo Island: All waters north of a line from Bat Point to Tsa Cove.

(*f*) Smeaton Bay, indenting mainland: All waters in Wilson and Bakewell Arms east of 130 degrees 40 minutes west longitude.

(*g*) Rudyerd Bay, indenting mainland: All waters in the north arm within 2 statute miles of the mouths of all salmon streams.

(*h*) Walker Cove, indenting mainland, tributary to Behm Canal: All waters within a line from Ledge Point to Hut Point.

(*i*) Chickamin River: All waters within a line from Fish Point to Trap Point.

(*j*) Yes Bay, Cleveland Peninsula: All waters within the bay and all waters outside the entrance within 1,000 yards of a line from Bluff Point to Syble Point.

(*k*) Shrimp Bay, west coast of Revillagigedo Island: All waters east of a line running south from Dress Point to the opposite shore.

(*l*) Traitors Cove, west coast of Revillagigedo Island: All waters of the cove within a line 50 yards outside the neck of the salt-water lagoon.

(*m*) Naha and Moser Bays, west shore of Revillagigedo Island: The waters of Long Arm and Moser Bay inside of a line from Cod Point to the opposite shore at 131 degrees 40 minutes west longitude and the waters of Naha Bay inside of a line extending due north from Cod Point.

(*n*) Moira Sound, east coast of Prince of Wales Island: All waters in South Arm and Frederick Cove, and within 1,000 yards of the mouths of all salmon streams in Johnson Cove.

(*o*) Cholmondeley Sound, east coast of Prince of Wales Island: All waters in Dora Bay and Sunny Cove.

(*p*) Skowl Arm, Prince of Wales Island: All waters within a line from Old Kasaan village to Khayyam Point.

(*q*) Kasaan Bay, east coast of Prince of Wales Island: All waters north of a line from Sandy Point to the east shore of the bay.

(*r*) Anan Creek: All waters within 1 statute mile from the mouth of creek.

(*s*) Wrangell Narrows: All waters between Point Alexander and Prolewy Point.

(*t*) Barrie Creek, southwest shore of Kupreanof Island north of Point Barrie: All waters within 1,000 yards of the mouth of the creek.

(*u*) Three Mile Arm, east coast of Kuiu Island: All waters within 1,000 yards of the mouths of all salmon streams.

(*v*) Seclusion Harbor, east coast of Kuiu Island: All waters within 1,000 yards of the mouths of all salmon streams.

(*w*) Port Beauclerc, southeastern coast of Kuiu Island: All waters within 1,000 yards of the mouths of all salmon streams tributary to Port Beauclerc.

(*x*) Affleck Canal, southeastern coast of Kuiu Island: All waters within 1,000 yards of the mouths of all salmon streams tributary to Affleck Canal.

(*y*) Tebenkof Bay, west coast of Kuiu Island: All waters in north arm of bay.

(*z*) Bay of Pillars, west coast of Kuiu Island: All waters in south arm of bay.

(*aa*) Security Bay, northwest shore of Kuiu Island: All waters within 1,000 yards of all salmon streams.

(*bb*) Saginaw Bay, northwest coast of Kuiu Island: All waters of the bay inside of a line beginning at the point of land at the northwest side of the entrance to Halleck Harbor and passing in a southwesterly direction at right angles to the general trend of the bay to the opposite shore.

(*cc*) Red Bluff Bay, east coast of Baranof Island: All waters in the bay; the waters of Falls Creek Bay are included.

(*dd*) Gut Bay, east coast of Baranof Island: All waters of the bay.

(*ee*) Redfish Bay, southwest shore of Baranof Island: All waters above a true east and west line passing through the southern end of the Second Narrows.

(*ff*) Redoubt Bay, west coast of Baranof Island: All waters within 1,000 yards of the mouth of the stream flowing from Redoubt Lake.

Herring fishery.—1. During the period from June 1 to October 15, both dates inclusive, commercial fishing for herring is prohibited in all waters closed throughout the year to salmon fishing.

2. Commercial fishing for herring is prohibited during the period from January 1 to May 31, both dates inclusive, and from October 15 to December 31, both dates inclusive, in each calendar year, with the following exceptions:

(*a*) Commercial fishing for herring may be conducted from March 15 to May 15, both dates inclusive, in waters in the vicinity of Sitka within a line from Halibut Point to Cape Burunof.

(*b*) Commercial fishing for herring may be conducted from January 1 to January 15, both dates inclusive, in the waters of Seward Passage and Ernest Sound.

(*c*) Commercial fishing for herring may be conducted from January 1 to February 15, both dates inclusive, in the waters of Clarence Strait within a radius of 3 statute miles of the town of Hadley, Tongass Narrows, Cholmondeley Sound, and Behm Canal and its tributary waters west of Bell Island to a line from Caamano Point to Point Higgins.

3. The closed seasons herein specified for herring fishing shall not apply to any boat taking not to exceed 60 barrels of herring in any calendar week in waters open to fishing.

4. No one shall place, or cause to be placed, across the entrance to any lagoon or bay any net or other device which will prevent the free passage at all times of herring in and out of said lagoon or bay.

5. All commercial fishing for herring is prohibited throughout the year in the waters of Kanalku Bay, Admiralty Island.

Clam fishery.—It is prohibited to take for commercial purposes any razor clam measuring less than 4½ inches in total length of shell. Possession of any razor clam of less than this length will be regarded as prima facie evidence of unlawful taking.

Shrimp fishery.—Commercial fishing for shrimps is prohibited in the period from March 15 to April 30, both dates inclusive, in each year.

Crab fishery.—Dungeness crab (*Cancer magister*). No female of this species shall be taken at any time, and no male of this species measuring less than 6½ inches in greatest width shall be taken for commercial purposes.

GENERAL REGULATIONS

By virtue of the authority conferred by the acts approved June 6, 1924, and June 26, 1906, the following regulations shall be effective in all waters of Alaska, including the special areas already described above:

1. During closed periods all salmon traps within the areas affected shall be closed in accordance with the method prescribed by section 5 of the act of June 6, 1924, and in addition the spillers of all driven traps shall be raised to within 4 feet of the capping and the spillers of floating traps shall be raised to within 4 feet of the surface (*a*) within 36 hours after the beginning of any seasonal closed period and (*b*) at the beginning of that part of any weekly closed period longer than 36 hours. Within 36 hours after the beginning of any seasonal closed period the tunnels from pots to spillers of all traps shall be entirely disconnected. In respect to traps not provided with spillers, the requirements in regard to spillers shall apply to the pots.

2. All persons engaged in fishery operations are warned to give due regard to all markers erected by the Department of Commerce.

3. In waters where a rack or weir is maintained by the Bureau of Fisheries for the purpose of counting salmon ascending to the spawning grounds records

of the catch of salmon shall be furnished daily by all operators to the local representative of the Bureau of Fisheries in charge, and upon notification by the Commissioner of Fisheries or his authorized representative that an excessive proportion of the run is being taken so that the escapement of any species is less than the 50 per cent specified by section 2 of the act of June 6, 1924, all commercial fishing operations shall at once be discontinued and shall not be resumed until permission therefor is granted by the Commissioner of Fisheries or his duly authorized representative. And if in any year it shall appear that the run of salmon in such waters has diminished there shall be required a correspondingly increased escapement, and upon notification by the Commissioner of Fisheries or his authorized representative all commercial fishery operations shall cease and shall not be resumed until such increased escapement has been secured.

4. The driving of salmon downstream and the causing of salmon to go outside the protected area at the mouth of any salmon stream are expressly prohibited.

5. During the inspection of the salmon fisheries by the agents and representatives of this department they shall have at all times free and unobstructed access to all canneries, salteries, and other fishing establishments and to all hatcheries.

6. All persons, companies, or corporations owning, operating, or using any stake net, set net, trap net, pound net, or fish wheel for taking salmon or other fishes shall cause to be placed in a conspicuous place on said trap net, pound net, stake net, set net, or fish wheel the name of the person, company, or corporation owning, operating, or using same, together with a distinctive number, letter, or name which shall identify each particular stake net, set net, trap net, pound net, or fish wheel, said lettering and numbering to consist of black figures and letters, not less than 6 inches in length, painted on white ground.

7. If in the process of curing salmon bellies the remaining edible portion of the fish is not used, such action will be regarded as wanton waste within the meaning of section 8 of the act of June 26, 1906, and those who engage in this practice will be reported for prosecution as provided for in the act.

8. These regulations do not apply to the Afognak Reservation, fishing within which is prohibited, except by resident natives, by the terms of the law and Executive order creating it.

9. The taking of salmon for fox feed shall be considered as commercial fishing and subject to all of the limitations in respect thereto.

10. Any increase in the amount of fishing gear employed or any expansion of fishery operations in any district in any season shall, in the discretion of the Secretary of Commerce, result in the immediate imposition of such additional restrictions as may appear necessary.

11. These regulations shall be subject to such change or revision by the Secretary of Commerce as may appear advisable from time to time. They shall be in full force and effect immediately from and after January 1, 1926.

AFOGNAK RESERVE

Salmon-fishing permits for Afognak waters were granted to 64 natives and residents of Afognak Island and certain adjacent islands during the season of 1925. Operations were carried on at eight localities, and beach seines only were used. Fishing began June 15 except at Little Afognak and Paramanof Bay, where it was not permitted until June 22. No fishing for red salmon was permitted at Litnik Bay. The total catch was 194,367 salmon, an increase of 12,938 over the catch in 1924. The catch of cohos decreased 3,998 and kings 393, while the catch of chums increased 2,698, humpbacks 11,625, and reds 3,006. These fish were sold to the Kadiak Fisheries Co., Katmai Packing Co., and Kodiak Island Fishing & Packing Co. As usual, some additional salmon were taken by the natives for food.

Before the opening of the season all fishing localities on Afognak Island were visited and new markers placed indicating the 500-yard closed zone off the stream mouths. It was reported that the runs were good at most localities, and a fair escapement resulted during the season. Some work was done in removing barriers in streams at

Seal Bay and Red Fox Bay to facilitate the ascent of salmon. Fred R. Lucas, then superintendent of the fish-cultural station on Afognak Island, supervised operations during the earlier part of the season.

A weir for fish-cultural purposes was maintained in Litnik River below the Afognak hatchery. From June 8 to August 15 a total of 5,544 red salmon passed through, and it was estimated that 3,000 additional fish ascended which could not be counted, making a total escapement of approximately 8,544.

Commercial catch of salmon, Afognak Island, season of 1925

Locality	Cohos	Chums	Humpbacks	Kings	Reds	Total
Little Afognak	9,296		756	8	14,278	24,338
Danger Bay	3,721		6,935		76	10,732
Litnik Bay	4,275					4,275
Paramanof Bay	27	2,842	20,913	5	27,399	51,186
Malina	3,369	241	9,701	32	28,031	41,374
Seal Bay	9,571		15,119	26	26,639	51,355
Izhut (Elia) Bay	276			11	8,639	8,926
Katine (Marqua)	2,181					2,181
Total	32,716	3,083	53,424	82	105,062	194,367

During the 1925 season there was an influx of herring operators to the waters of the Afognak reserve, some operating from plants located just outside the reserve and others with floating plants anchored in protected waters of the reserve. It is the policy of the bureau not to permit the establishment of herring shore stations on Afognak Island. The packing of herring is prohibited in Red Fox Bay, where the largest run occurs, and a seasonal limitation has also been imposed. A number of other restrictions have been placed on herring operations in order to safeguard the salmon-fishing of the natives.

ANNETTE ISLAND FISHERY RESERVE

The Annette Island Packing Co. again operated in the Annette Island fishery reserve in 1925 under its lease from the Department of the Interior. Data regarding fishery operations have been furnished by the Bureau of Education of that department, which administers the affairs of the reserve for the benefit of the Metlakatla Indians residing there.

In 1925 the total number of fish taken from traps within the reserve was 592,004 of all species, on which royalties amounting to $6,477.49 were paid. The per-case tax on canned salmon under the Territorial law, which is payable to the Metlakatla Indians, amounted to $1,854; trap fees on six traps, at $200 each, amounted to $1,200; and rental of cannery buildings was $3,000. In addition $31,026.15 was paid to 162 natives for labor, $3,589.10 for lumber and piling, and $14,201.48 for fish taken by seines, making a grand total amount disbursed by the Annette Island Packing Co. to the natives of $61,348.22. Corresponding disbursements the preceding year were $71,761.57.

ALASKA FISHERY INTELLIGENCE SERVICE

As has been the practice for several years, the bureau continued to report by telegraph to the important points in southeastern and central Alaska the prices of fresh fish (chiefly halibut) at Juneau, Ketchikan, and Seattle. During the closed season on halibut the service was discontinued, as the quantities of other fresh fish sold are negligible during that period.

STREAM MARKING

As a result of the decision of the United States Circuit Court of Appeals for the Ninth Circuit, on June 29, 1925, in the Booth Fisheries Co. case, to the effect that it is not unlawful to operate a trap or to fish within 500 yards or greater prohibited distance of the mouth of a stream unless the mouth has been officially marked, it became necessary to proceed as rapidly as possible with the marking of the mouths of all salmon streams in Alaska. The work was carried on throughout the season and also during favorable weather of fall and winter, and it is expected will be completed before the opening of the fishing season of 1926. It has been estimated that there are about 1,300 salmon streams in Alaska in districts where commercial fishing is carried on. All streams in the Yukon, Kuskokwim, Bristol Bay, Alaska Peninsula, Chignik, and Kodiak districts were marked this season. Notwithstanding the decision of the court, there appeared to be no disposition on the part of trap operators to locate traps near streams that had not been marked in the season of 1925.

STREAM GUARDS

The bureau employed 128 men as stream guards in 1925. Of these, 74 were stationed in southeastern Alaska, 33 in central, and 21 in western Alaska. The period of employment ranged from two to five months.

In southeastern Alaska 22 of the guards furnished their own launches, and each of these men was assigned to patrol a body of water such as a bay, inlet, or around the mouths of several streams.

In central Alaska 14 stream guards were situated in the Copper River and Prince William Sound districts, 6 in Cook Inlet, 8 in the Kodiak-Afognak district, one at Chignik, and 4 in the Ikatan-Shumagin district.

In western Alaska 1 guard was stationed at Port Moller, 18 in Bristol Bay, and 2 on the Yukon River.

There were also 4 special employees, 1 on a salmon investigation in central and western Alaska, 1 each on clam and herring investigations in the Cordova region, and 1 making a special survey of the spawning grounds of the Copper River.

In addition, there were 5 statutory employees of the bureau in southeastern Alaska, 5 in central, and 3 in western. There were also 24 persons on the bureau's vessels and 16 on the 11 boats chartered in various districts.

The foregoing makes a grand total of 185 persons identified with fishery-protective work in Alaska in 1925.

VESSEL PATROL

Ten vessels owned by the bureau were operated in the fishery patrol work in Alaska in 1925. Of these, the *Auklet*, *Murre*, *Petrel*, and *Widgeon* were used in southeastern Alaska; the *Kittiwake* in Cook Inlet and Prince William Sound; the *Blue Wing* at Kodiak and Afognak Islands; the *Ibis* at Chignik; the *Merganser* in the Ikatan-Shumagin region; the *Scoter* in Bristol Bay; and the *Tern* on the Yukon River.

The Pribilof Islands tender *Eider* also rendered assistance in salmon work at various times during the season. From June 10 to 13 Agent Dennis Winn was transported from Naknek to Port Moller, and early in July the vessel was assigned to salmon patrol throughout southwestern Alaska. Dr. C. H. Gilbert was on board from July 3 to 16 for the purpose of visiting salmon canneries and fishing grounds in

FIG. 1.—*Ibis*. Chignik

that region. Transportation was furnished Doctor Gilbert in September also from Larsen Bay to Seward.

Launch *No. 43*, assigned to the Afognak hatchery, was used during part of the season in connection with the fishery patrol in the Afognak-Kodiak region.

The following chartered vessels were used in fisheries patrol: *Anona*, *Daring*, *Murrelet*, *Diamond T*, and *Diana*, in southeastern Alaska; *Lily*, *Prospector*, *Puffin*, and *King* in Prince William Sound; *Auk* in the Ikatan and Port Moller districts; and *Robin* on the Kuskokwim. Six small boats owned by the packers in Bristol Bay were operated by the bureau in predatory-fish work and also used for fishery patrol during the salmon-fishing season. Three other small boats were chartered for patrol in Bristol Bay, one each at Nushagak and Egegik during the weekly closed periods, and one throughout the commercial season in the Kvichak area.

COMPLAINTS AND PROSECUTIONS

During the season of 1925 four salmon traps were seized in southeastern Alaska for illegal fishing. In the cases against Mahoney & Kettles and the Auk Bay Salmon Canning Co. the traps were condemned and sold under court order. The watchman on the Auk Bay Salmon Canning Co.'s trap was sentenced to 30 days in jail and fined $100. The trap of the Nakat Packing Corporation was not seized at the time the violation was detected, and the United States attorney felt it was doubtful whether confiscation proceedings could be had. The trap was permitted to operate under $3,000 bond, and on trial the company was fined $250 and the trap was released. A trap of the Pacific American Fisheries was seized for illegal fishing during the weekly closed period, but on a showing that it was the result of an honest mistake of the watchman, the trap was released and a fine of $25 and costs of $3.80 were imposed on the watchman.

Traps installed in Icy Strait by the Deep Sea Salmon Co. and the Astoria & Puget Sound Canning Co. were found to be less than the required 1½ miles apart. An injunction was issued by the court against the operation of both traps, and the case was settled by the Deep Sea Salmon Co. removing its trap the required distance from the other.

A case against the Alaska Pacific Fisheries on the seizure of a trap in 1924 was still pending at the end of 1925.

Seven Indians were arrested for fishing in a creek at Excursion Inlet and were fined $75 and costs of $25.80 each.

George John, an Indian operating the gas boat *Fox Trot*, was fined $100 for fishing in a creek in the vicinity of Dundas Bay.

Lewis Stockley, a fox farmer near Ketchikan, was prosecuted for illegal fishing for salmon, and when tried (December 23) pleaded guilty and was fined $100 and costs of $13.

Two Canadian vessels were seized by United States Coast Guard cutters *Smith* and *Cygan* in July, 1924, for fishing in Alaskan waters. A fine of $100 was imposed in each case and the vessels were released.

A careful investigation of the alleged waste of herring and illegal practices of herring fishermen in southeastern Alaska was made by representatives of the bureau, agents of the Department of Justice, and the grand jury at Juneau in the summer and fall of 1925. Although there were rumors of waste of herring, definite evidence that would support prosecutions could not be obtained. The basis of the allegations seemed to be the use of large quantities of herring for the manufacture of fertilizer and the occasional dumping of dead herring or of a small surplus that could not be handled by the curers.

Considerable opposition has been voiced in southeastern Alaska against the use of herring in large quantities by reduction plants, but there is no authority of law by which this use can be curtailed or the companies forced to utilize any portion of the catch for food products. A number of investigations were made in southeastern Alaska on complaint of various companies and individuals, but no legal action resulted. One cannery was reported to be packing fish illegally taken during the closed season, but evidence to warrant a prosecution could not be secured. It was also alleged that white men were fishing in the Annette Island Fishery Reserve; that a number of seine boats in the Ketchikan district were using seines of greater

than the legal length; and that certain traps were nearer to the mouths of salmon streams than is allowed. Upon investigation there was found to have been no violation in any of these cases.

In the case of the Booth Fisheries Co., instituted in 1924 for maintaining and operating a trap within 500 yards of a salmon stream at Lucky Cove, and which resulted in a conviction and fine of $1,900, the United States Circuit Court for the Ninth Circuit, on June 29, 1925, reversed the decision of the lower court. It was held that the trial court erred in instructing the jury as to the method of determining the mouth of a salmon stream, and that until the mouth of a stream has been officially marked it will be impossible to determine the boundaries of the prohibited area off such stream. In view of the language of the statute, application for rehearing was not made.

FIG. 2.—*Tern*. Yukon River

In the Copper River district three fishermen were arrested for fishing in the sloughs, their gear was confiscated, and fines of $75 each were imposed.

In the Cook Inlet district 11 fishermen were arrested for fishing during the weekly closed period. All were sentenced to 10 days in jail and the gear operated by them was confiscated and sold under court order.

A number of cases instituted in Cook Inlet in 1924 were still pending at the beginning of 1925. Two traps seized from Libby, McNeill & Libby in August, 1924, were released, but the criminal case against the company was still pending at the end of 1925. A trap seized from the Northwestern Fisheries Co. in August, 1924, was released, but on trial of the criminal case in October, 1925, the company was fined $200. Three traps seized from H. J. Emard were released, and the jury returned an instructed verdict of not guilty of wanton waste of salmon. The libel suits in all these cases were

dismissed because of faulty pleadings. In the case of the *Commander* and *Waterland*, seized from W. J. Imlach & Co. for wanton waste of herring, the jury returned an instructed verdict of not guilty as to the company and the crews, and the vessels were released. The *Altana* and *Pennsylvania*, seized from the San Juan Fishing & Packing Co. on the same charge, were also released and the case against the company dismissed.

In Bristol Bay four fishermen were arrested for illegal fishing during the 1925 season and fined $75 each. Complaint was received of waste of salmon by a packer at Nushagak, and all information was turned over to the United States attorney at Valdez.

The case against Louis Knaflich for illegal fishing in the Kuskokwim River in 1924 was still pending at the end of the year.

ROBBERY OF FISH TRAPS

Fish piracy, or the robbery of fish traps, which in previous seasons was bitterly complained of by salmon canners in southeastern Alaska, was reduced to a minimum during the season of 1925. This was accomplished chiefly through the maintenance of a patrol organized by the larger canners and operated under the supervision of deputy United States marshals. A number of cruising boats were engaged in this patrol and covered waters in the vicinity of Icy Strait, Niblack, Street Island, Behm Canal, Kanagunut, Rose Inlet, Dall Head, Hidden Inlet, Union Bay, and the west coast of Prince of Wales Island.

TERRITORIAL FISHERY LEGISLATION

At its biennial session in 1925, the Legislature of Alaska passed two acts applying to the fisheries of the Territory, both of which were made immediately effective upon approval, April 30, 1925.

The first of these amended the act of 1923 in regard to licensing fishermen, and made operative the following license fees:

Resident fishermen of all classes	$1
Nonresident fishermen who use any fishing appliance except seines	10
Nonresident fishermen who use seines	25

The second act amended the license tax law of 1921, as amended in 1923, by reducing the tax from 15 cents to 5 cents per 100 pounds of mild-cured red king salmon, and from 5 cents to 2½ cents per 100 pounds of mild-cured white king salmon.

The United States Supreme Court rendered a decision on December 7, 1925, in the case of the Pacific American Fisheries, petitioner, *v.* Territory of Alaska, a test case brought to determine the constitutionality of the graduated pack tax imposed by the Territorial law of May 5, 1923. Decisions of the district court at Juneau and the Circuit Court of Appeals for the Ninth Circuit had previously upheld the power of the Territory to impose such a tax, and the case came before the Supreme Court on writ of certiorari.

This case was of particular interest in view of the contention of the petitioner that the tax was not a revenue measure, as it purported to be, but an attempt to regulate fisheries contrary to the act of August 24, 1912, creating a legislative assembly in the Territory of Alaska, which provided that the authority therein granted to alter,

amend, modify, and repeal laws in force in Alaska should not extend to the game, fish, and fur-seal laws. The Supreme Court held that the legislature might act with the intent to discourage canning larger amounts, and that canneries, not fisheries, were the direct object of attack. It was held that any tax is a discouragement and therefore a regulation so far as it goes, and that the unlimited power to tax, expressly given, may be exercised with consideration of collateral advantages and disadvantages.

The decision of the Supreme Court is as follows:

This is a suit by the Territory of Alaska to recover from the petitioner, Pacific American Fisheries, license taxes alleged to be due upon cases of salmon packed by the defendant at four canneries named. The defendant in its answer set up that the Territorial taxing act was contrary to the act of Congress of August 24, 1912 (c. 387 (sec. 3), 37 Stat. 512), creating a legislative assembly in the Territory of Alaska, and to the Constitution of the United States. The Territory demurred; there was a judgment for the plaintiff, and this was affirmed by the circuit court of appeals (2 Fed. Rep. (2d) 9). A writ of certiorari was granted by this court (267 U. S. 589).

The taxes in question were imposed by chapter 101, section 2, subdivision 8, Laws of Alaska, 1923, amending chapter 31 of the Laws of 1921. By (*c*) of that subdivision salmon canneries, after a tax by (*b*) of 10 cents per case, are charged an additional tax on a pack of kings, reds, and sockeyes, counted together, at any one cannery, as follows: On all cases in excess of 10,000 and not more than 25,000, 5 cents per case; in excess of 25,000 and not more than 40,000, 10 cents per case; in excess of 40,000 and not more than 50,000, 15 cents per case; and on all in excess of 50,000, 20 cents per case. Similarly in (*d*) and (*e*) a tax of 4½ cents per case is imposed on medium reds, cohos, and pinks; with additional taxes for each increase of numbers as in the previous subdivision. By (*f*) chums are taxed 3 cents per case. The petitioner says that this graduated tax is inconsistent with the act of Congress mentioned, which provides that the authority therein granted to alter, amend, modify, and repeal laws in force in Alaska should not extend to the game, fish, and fur-seal laws, and presses this contention notwithstanding the further proviso that this provision shall not operate to prevent the legislature from imposing other and additional taxes or licenses. The petitioner also says that the classification upon which the surtax is based is unreasonable and a denial of due process of law, contrary to the fifth amendment of the Constitution of the United States. No question is raised about the uniform tax of 10 cents per case imposed by (*b*). That has been paid.

The petitioner offers various reasons to show that this tax is not what it purports to be but is an attempt to regulate fisheries, which the petitioner believes Congress has not given the Territory power to regulate. The answer alleges that it was known that the revenue from these taxes would exceed the appropriations and needs of the Territory, and from this and other things the conclusion is drawn that the taxes were levied with the intent of driving the defendant out of its business. But the premise could not be known, it only could be prophesied. If known the conclusion as to legislative intent would not follow; and if the intent were entertained, in the only sense in which it rationally could be imputed—that is, to discourage canning the larger amounts—the legislature lawfully might act with that intent. Fisheries were not the direct object of attack, but canneries. It would require a strong case in any event to invalidate a tax on things that the legislature had power to regulate because of its collateral reaction on something else. But here even as to fisheries the legislature is given power to tax. Any tax is a discouragement and therefore a regulation so far as it goes, and the most plausible reconciliation of this power with the restrictions upon amending or modifying the laws in force is that the only purpose of the restrictions was to prevent the Territory from doing away with all protection, in a shortsighted rush for fish. At least we must take it to be clear that the unlimited power expressly given may be exercised with consideration of collateral advantages and disadvantages. (Alaska Fish Salting and By-Products Co. *v.* Smith, 255 U. S. 44, 48.) It could not be exercised intelligently otherwise. The extent of the power is a question of specific interpretation not of general principle; and therefore we leave the many familiar cases that were cited on one side.

It is not unworthy of notice that in section 9 of the act of August 24, 1912, an earlier statute of July 30, 1886 (c. 818, sec. 1, 24 Stat. 170), is taken up, in which

the power of the Territorial legislatures to pass laws for the protection of game and fish is recognized, and also that the latest revision of the fish law by Congress was passed after the present tax law had been enacted and had been upheld by the district court; that it provided that nothing therein contained should curtail the powers of the Territorial legislature of Alaska, and that it showed no sign of dissatisfaction with the way in which those powers had been used. (Act of June 6, 1924, c. 272, sec. 8, 43 Stat. 464, 467.)

It is much pressed that the tax discriminates against large canneries in favor of small ones—this especially as contravening the fifth amendment and denying due process of law. Classification of taxes by the amount of the corpus taxed has been sustained in various connections heretofore. By way of specific answer it is pointed out by the attorney general of Alaska that the size of the run of salmon can not be foreseen; that a cannery must be prepared to its full capacity; that there always will be an irreducible minimum of expense to be borne whatever the size of the pack; that therefore a small pack may mean a loss and a larger one a profit; and that on these considerations the law justly may attempt to proportion the tax to the probable gains. The inequalities of the tax are based upon intelligible grounds of policy and can not be said to deny the petitioner its constitutional rights.

Judgment affirmed.

TERRITORIAL LICENSE TAX

Fisheries license taxes were collected by the Territory under the general revenue law of 1921, as amended in 1923 and 1925. A statement from W. G. Smith, Territorial treasurer, under date of April 7, 1926, gives the collections made to that date for the year 1925. It was stated that collections were complete with the exception of pack taxes due from a few of the smaller canneries and fish salteries and also those on whale oil and fertilizer.

Fishery license taxes collected by Territory for fiscal year ended December 31, 1925

Schedule	Division No. 1	Division No. 2	Division No. 3	Total
Salmon canneries (pack)	$137,147.02	----------	$148,373.61	$285,520.63
Salmon canneries (net income)	4,932.06	----------	10,464.17	15,396.23
Clam canneries	----------	----------	564.13	564.13
Salteries	3,130.72	$26.54	7,800.92	10,958.18
Cold-storage plants	1,825.00	----------	375.00	2,200.00
Fresh-fish dealers	4,054.74	----------	17.52	4,072.26
Fish-oil works and fertilizer and fish-meal plants	18,095.64	----------	1,763.60	19,859.24
Fish traps	95,169.46	----------	31,864.21	127,033.67
Gill nets	638.00	20.00	6,092.50	6,750.50
Seines	5,490.00	----------	1,950.00	7,440.00
Total	270,482.64	46.54	209,265.66	479,794.84

In addition to the collections shown in the table above, the treasurer stated that collections of the graduated pack tax and the tax on excess salmon caught in traps, together with penalties and interest, were being made for the years 1923 and 1924. The payment of these taxes was withheld pending final decision in a case brought by the Territory against the Pacific American Fisheries to test the constitutionality of the law passed by the legislature in 1923. Decision was rendered by the United States Supreme Court on December 7, 1925, confirming the decision of the lower courts as to the authority of the legislature to impose such taxes. This decision is further referred to under the heading of "Territorial fishery legislation" in this document. In explaining these additional collections Mr. Smith states:

A few of the cannery companies held out the additional tax due on fish caught in each fish trap in excess of 100,000 and hence we show several thousand dollars

collected under such schedule for back years in addition to amounts previously reported to you for the years 1923 and 1924. According to tax statements held on temporary file, we still have to collect quite a considerable sum in graduated pack taxes for the back years, the amounts outstanding being approximately $30,500 for the year 1923 and $18,300 for the year 1924. Most of this money will no doubt be collected within the next 30 or 60 days.

Additional tax collections for 1923 and 1924, not included in previous statements

1923:	
Graduated pack tax on canned salmon	$108,267.58
Tax on salmon in excess of 100,000 caught in traps	3,329.78
1924:	
Graduated pack tax on canned salmon	57,390.26
Tax on salmon in excess of 100,000 caught in traps	2,887.33
Penalty and interest on above payments	42,320.68
Total	214,195.63

BRISTOL BAY DISTRICT

Work in the Bristol Bay region in 1925 consisted of a survey of lakes and spawning grounds, improvement of salmon streams, destruction of predatory fishes, and the enforcement of the fishery laws and regulations during the active salmon-fishing season. As in previous seasons, operations were under the general direction of Agent Dennis Winn, who was in the district during the early part of the season and gave personal attention to the inauguration of the work in the various sections. Warden A. T. Looff later took active charge.

Transportation for a special force of 19 employees from the States was afforded on vessels of the Alaska Packers Association, the Alaska-Portland Packers Association, the Columbia River Packers Association, the Naknek Packing Co., and Libby, McNeill & Libby. This force, with two employees who had remained in the district over the preceding winter and three others who arrived early in the season by commercial steamer, comprised the bureau's working party for the season. The same cannery ships furnished return transportation to the States for 14 men at the end of the season. The companies also cooperated by transporting all necessary supplies for the bureau's work.

Mr. Winn's report is as follows:

GENERAL REPORT OF SEASON'S OPERATIONS

The work on predatory fish throughout the season was not as satisfactory as in other years, due to the extremely short season. The sailing ships of the canners are being superseded by steamers, hence they leave the States at a late date and reach Bering Sea only in time to prepare for the season's operations. Fishing lasted only 24 days, including Sundays, on the Kvichak-Naknek side of the bay and 26 days on the Nushagak side. As the only transportation for the bureau's employees was on cannery boats, the period of operations at the longest was limited to two months. In view of this handicap the Commissioner of Fisheries has instructed that all heretofore cooperative operations be conducted in connection with the bureau's patrol until more efficient and satisfactory plans can be formulated with regard to anticipated additions to the bureau's fleet of vessels.

Freight, including equipment and supplies, was transported by the Alaska-Portland Packers Association from Portland, the Alaska Packers Association from San Francisco, and the Northwestern Fisheries Co. from Seattle. The Alaska-Portland Packers Association also transported two new launches and three

18-foot skiff launches for the bureau's use. These small launches proved a valuable addition to the equipment, as they save time and labor in ascending the rivers and are capable of passing up the rapids in the Naknek under their own power whereas formerly it was necessary to line the boats over a long haul where the stream was too deep for wading. The latter company also transported piling, timbers, hardware, etc., for the construction of the bureau's marine ways on Naknek River.

DESTRUCTION OF PREDATORY FISHES

Iliamna Lake.—The previous spring work having been satisfactory, it was believed that good work could be accomplished late in the fall in the destruction of predatory fishes and that a man detailed in that locality for the winter could, with a little local assistance, operate on trout efficiently and to good advantage. Therefore, Warden F. G. Morton was detailed to this work in the winter of 1924–25. After a survey of the spawning grounds by the writer and Mr. Morton, in the fall of 1924 quarters were secured for the latter near Chekok Creek on the north shore of the lake, where he began operations.

Mr. Morton's first camp was established at Iliamna and Pile Bay, where fair catches were made with gill nets and seines during part of September and early in October. During the latter part of October the formation of ice caused the cessation of operations in this vicinity. At that time the trout were descending the stream into the lake, but never in large numbers. A total catch of 2,785 Dolly Vardens was made there.

Camp was then transferred to the Chekok and Goose Bay districts, where operations were conducted until November 17, and 4,559 Dolly Varden trout, averaging 2½ pounds each, or 11,397 pounds, were caught. The streams along the north shore were prospected, but the ice prevented any noteworthy work.

On November 12 Mr. Morton reported seeing large quantities of smelts that had been washed in on the sandy beach of the lake near Goose Bay by the severe storms, many of them so full of spawn that they burst open.

Early spring activities were centered at Chekok, Pedro Bay, and Woody Islands, the only points open that contained any trout. When the upper end of the lake was clear of ice the entire shore was prospected, but with poor results. Traps were installed in some of the streams, but very few trout were noticed at any point and the catch was small. By May 16 it became possible to operate in the Iliamna River, which was fully three weeks later than in 1924. A thorough survey of the stream disclosed but one school of about 100 Dolly Vardens. Another crew operated at Chekok and Goose Bay, but results there were also discouraging.

On June 3 Mr. Morton and a native assistant made a survey along the east and south shores of the lake and visited all the tributary streams en route. Few trout were noticed at any point. Mr. Morton reported more salmon fry descending into the lake from Copper River than from all the other streams together. On his arrival at the foot of the lake (June 11) a few red salmon and many Dolly Varden trout were entering. He went on to Koggiung and was on salmon patrol for the remainder of the season.

During the spring 694 trout were taken, making a total for fall and spring work of 5,253 Dolly Varden trout, weighing 13,132 pounds, an average of 2½ pounds each. Based on results of operations in this district over a series of years, it is apparent that unless the salmon season of the previous year was good the spring trout work usually is negligible. The young salmon that descend the streams into the lake constitute the attraction for trout.

Naknek.—The Naknek party, with Gus Severson in charge, reached Naknek anchorage on May 27 and the following day went ashore to the cannery where boats, supplies, and equipment were assembled. The party proceeded upriver on May 31 and established the first camp at the lake outlet, where good work was accomplished for a few days. At the time of arrival a big downward migration of young salmon was in progress. Camp was moved June 7 to the eastern end of the lake, from which point a skiff was carried over the portage and operations were begun in Grosvenor and Coville Lakes. Gill nets were used to good advantage until June 14, when the salmon appeared and it became necessary to remove the nets. Camp was then established at Kidawik Creek on June 16, where set and hand lines were used with poor results to the end of the season. As one of the bureau's wardens will remain in the Naknek district during the winter it will be possible to secure information in regard to late fall conditions, of which nothing is now known, and operations will be begun in the early spring as soon as ice and weather conditions permit.

In this district 1,184 lake trout were destroyed, averaging 10 pounds each, or a total of 11,840 pounds.

Becharof Lake.—H. B. Looff, with a crew of two men for Becharof Lake, proceeded from Seattle, on March 28 by regular transportation steamer to Kanatak, arriving April 10.

Supplies and equipment were assembled at Kanatak, and the party started for Becharof Lake. Heavy snow impeded progress, but the lake was reached on April 12 and headquarters were established in the halfway camp of the Standard Oil Co. The following day fishing with gill nets was begun, although the weather was cold and it was snowing. Fishing continued with discouraging results, owing to the extreme cold and heavy snowfall practically every day up to early May. The weather then changed and floods occurred and little fishing was possible. By May 12 the creeks began to subside and clear, when the nets were again set out and fishing gradually improved.

All the streams along the eastern shore were visited several times throughout the season, and toward the end of June good catches were made. Gill nets placed across the mouths of streams were very effective, but more fish were taken with hand lines. This field was well covered, and it is the opinion of Mr. Looff, who has worked in this district for the past five years, that the trout are becoming scarcer each year and consequently more difficult to secure. At no time were the numbers found equal to previous years.

During the season Mr. Looff made two trips overland to the upper tributaries of the Ugashik Lakes, where fair catches were made. On July 8, when the first visit was made, but few trout were in the streams and only 185 Dolly Vardens were taken. On a trip made on August 14 fishing was much better, and in four hours of hand-line fishing 1,150 Dolly Vardens were taken, averaging 2 pounds each. Valuable information regarding the spawning habits of the trout was secured on this late visit, and it is felt that late operations should be carried on in all sections with the possible exception of Naknek.

The catch for the season, including the trout taken at Ugashik, was 25,035 Dolly Varden trout, averaging 1 pound each. Mr. Looff reported greater numbers of salmon fry coming from the gravel this season than in any previous year, and all Dolly Vardens caught near the spawning grounds had stomachs full of fry. The stomach of one medium-sized Dolly Varden contained, by actual count, 636 salmon fry.

Ugashik.—Aside from the investigation of the upper watershed of the Ugashik, activities were chiefly centered on the main stream and in preparations for the construction of a counting weir on the upper Ugashik River, which will be operated during the coming season. In connection with this weir it is hoped to accomplish considerable good by intercepting the outgoing migration of trout and getting a check at least on those entering with the salmon.

Wood River.—The Wood River crew left April 18 on the Columbia River Packers Association ship *Chillicothe* and arrived at anchorage outside the creek cannery on May 18. The ice descending the river caused the *Chillicothe* to break her moorings, but she was towed out of the ice and anchored off Ekok, where she remained during the height of the storm and returned to anchorage above Clark Point on May 25. On the following day the Wood River crew was transferred to Snag Point on one of the small patrol launches. Supplies and equipment were assembled, and the party left for the lake on May 28. Ice was still passing down river, and when the party arrived the lake was found to be completely blocked.

Work about the lake outlet was carried on with poor results until June 14, when a slight improvement was noticeable and the lake opened up so the operators could transfer camp to its head. Owing to failure to secure several local residents who had been engaged the previous year, it became necessary to bring most of the crew down for Sunday patrol in the upper bay, which curtailed the trout work to that extent. Operations were discontinued on July 29 in order to secure transportation on the *Chillicothe*, which left for the States August 4.

During the season 4,384 Dolly Varden trout were taken, averaging 2 pounds each, a total of 8,768 pounds. Few good catches were recorded, and trout were not noticed schooling in any numbers throughout the season. Also, as the season advanced the trout disappeared almost entirely in the lower lake region. Possibly they ascended to the upper lakes, but this could not be ascertained owing to the short season. It is very noticeable that the trout are diminishing in size each season and that the average weight has dropped from 5 to 2 pounds since this work was begun.

Predatory fish taken in 1925 [1]

Location operated	Fish taken	Average weight	Total weight
	Number	*Pounds*	*Pounds*
Iliamna	5,253	2½	13,132
Naknek	1,184	10	11,840
Becharof (including Ugashik)	25,035	1	25,035
Wood River	4,384	2	8,768
Total	35,856		58,775

[1] The fish taken at Naknek were lake trout; all others were Dolly Vardens.

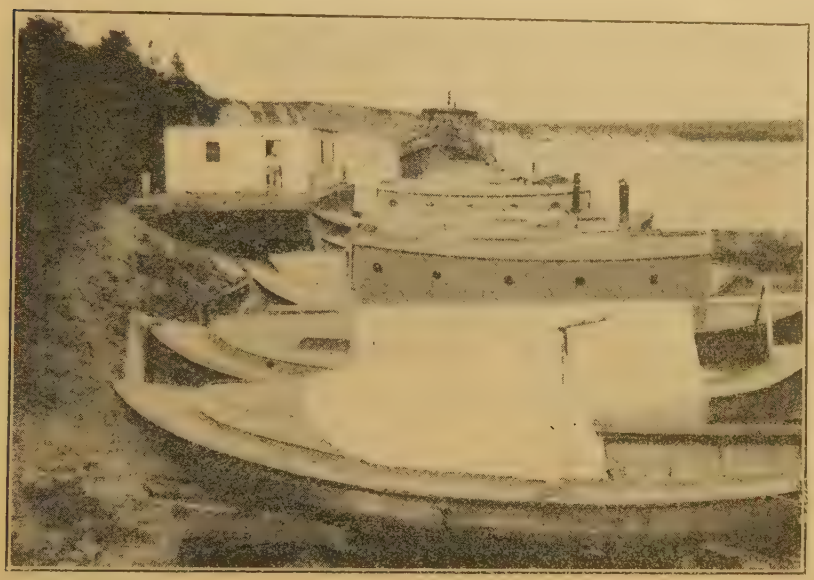

FIG. 3.—Patrol boats on bureau's marine ways, Naknek River

PATROL

The patrol this season was effective in all sections. The addition of launch *No. 7* was of great benefit, especially in the patrolling of the flats during the Sunday closed periods. This boat is of cruiser model, semitunnel type, 36 feet long, with 40 to 60 horsepower Red Wing engine, and has sufficient power and speed to ascend the streams with ease, which, with her shallow draft, made it possible to cover great areas during the weekly closed period in sections that could not be visited heretofore.

Another valuable addition was launch *No. 5*, of the Columbia River type, equipped with an 8-horsepower Frisco Standard engine. This launch replaced the boat lost by fire last year in the Ugashik River and is an excellent boat well suited for the work for which it is intended.

With the present equipment, the bureau is well prepared to handle the patrol situation in Bristol Bay. Few violations were reported throughout the season, and it is felt that greater effort was made by the fishermen to observe the laws this season than formerly.

The Naknek River marine ways, which were constructed during the summer months and are suitable to care for all of the bureau's launches and boats in the district, are now ready for use. The engineer assigned to the *Scoter* has been detailed for work on these boats during the winter of 1925-26. He is to work under the direction of Warden A. T. Looff, who will remain in Bristol Bay for the

winter to make a survey of the Snake and Igushik Lakes in connection with salmon and spawning area possibilities. Mr. Looff will begin work on predatory fish in Naknek Lake at the carliest possible date in the spring. The engineer will have all floating equipment, especially the launches, painted and in perfect running order, so that they can be put into service immediately upon arrival of the regular force in the spring.

A tally scow, fitted with suitable living quarters, has been placed on the ways and another will be added the coming season. These will be the bureau's headquarters in Bristol Bay. It is intended to detail reliable operators here each winter to keep the boats in good repair and make investigations of conditions at each lake. Maps of the lake country will be made and its salmon possibilities thoroughly studied. It is felt that in this way a record can be obtained as to local conditions and the possible damage to the spawning grounds from floods or other causes, which in a measure might impair the effects of a good seasonal escapement. Henry Looff reports that the floods of early May in the upper Becharof district washed many eyed eggs downstream, which he feels certain could only be those of red salmon. The trout taken at that time also were gorged with eggs. There was some previous information relative to fry in gravel on the spawning beds late in the summer, which would be in line with the above, but there has been no opportunity previously to make a full investigation. It is hoped that with present facilities it will be possible to secure reliable investigators for year-round observations.

RUN OF SALMON AND ESCAPEMENT

During the past season the salmon run in Bristol Bay, with the exception of the Nushagak area, was practically a failure. Throughout the season the salmon were small, especially those along the entire east shore. The total pack of the 28 canneries was 568,165 cases, on the basis of forty-eight 1-pound cans to the case. Of this total 92 per cent was red salmon, 3 per cent kings, 4½ per cent chums, and one-fourth of 1 per cent cohos.

At Naknek the first salmon appeared early in June and reached Coville Lake June 14. The escapement, as reported, was very light but quite steady during the entire season and increased perceptibly after the close of commercial fishing.

At Becharof the escapement was about half that of 1924, when A. T. Looff reported that all available spawning areas were amply seeded. In 1925 a few salmon arrived at the lake early in June, but it was not until July 1 that any large numbers came. By far the larger numbers arrived after August 10. Bright salmon were noticed entering August 17. The average weight of many specimens taken by the natives for food was 4½ pounds.

At no time was the run of salmon large at Ugashik and most of the ascending fish were of a size small enough to easily pass through the meshes of the gill nets. The complaints of the fishermen also bear out this observation.

At Nushagak the first red salmon was noticed entering the Wood River Lakes on June 12, but large numbers did not appear until July 2, when the inrush began and it was necessary to remove the set nets. The escapement was good, reaching its peak July 9 and continuing until July 13, after which there was a perceptible lessening and only a few fish escaped after July 19. However, the employee in charge of the district advised that owing to the heavy inrush from July 9 to July 13 the escapement was good, though not on a par with that of last year, which was considered adequate so far as could be judged from an estimate of the number of ascending fish. This employee has been in the district for the past four years.

INSPECTION OF ILIAMNA AND LAKE CLARK SPAWNING AREAS

On August 14 the writer left Juneau on the *Admiral Watson* for Kodiak en route to the Bristol Bay district. After completing an inspection of operations at Kodiak and Afognak Islands he went on board the *Kittiwake*, which had been ordered to Kodiak, and reached Iliamna Bay August 24. A survey of the spawning grounds in the immediate vicinity was begun the following day.

The Iliamna River received practically no salmon this year and the natives did not catch enough to eat at any time during the season. They prospected every stream where a few salmon could be caught and found but a small proportion of the number taken in average years. All were taken in the streams along the north shore and away from Iliamna River. Visits were made to all

the principal spawning areas in the district, and everywhere the same depleted condition was observed. Practically all the fish entering some of the smaller streams were taken by natives for home consumption and dog feed. This was especially true of Belinda Creek, where about 4,000 salmon were captured by local natives. At Tommy Creek the natives reported 75 bundles dried, or 3,000 salmon; at Tularic Creek 25 bundles were reported, representing 1,000 red salmon. At Kokhonak Creek one family of natives camped near the mouth of the river had about 500 red salmon drying on their racks, some in the last stages of decomposition and many drying uncut. These fish were hooked on the spawning grounds.

The salmon were very small here. Dead specimens taken at random at various points along the shore were measured, and nearly all were from 19 to 22 inches long. Salmon 24 or 25 inches long were conspicuous because of their size and scarcity. In this stream very few spent fish were dead, and with the exception of one school of about 200 all were on the spawning beds. None were seen at the stream entrance. This stream was very sparsely seeded even in the lower reaches where the salmon were most numerous, and they disappeared almost entirely in the upper reaches.

It was estimated that 15,000 red salmon reached Kokhonak Creek this season, or about 9 per cent of last year's run, which also was small in comparison with the runs of other years.

Conditions in Copper River were similar to those in Kokhonak Creek with respect to number and size of fish. In this stream about half the fish were dead (having spawned) and the others were spawning. The fish (red salmon) dead on the banks and in the water, as well as those alive in the stream, were carefully counted and together totaled about 25,000, or 17 per cent of the number present last year. No natives were here at the time of inspection.

At Newhalen, the only place where the natives fished successfully, they captured about 10,000 red salmon. Very few fish were seen at the time of our visit, and it was presumed they had either passed upstream or been taken for food. While ascending the Newhalen River en route to Lake Clark, few spawners were noticed, and only a few were on the drying racks in the fish villages passed.

Very few fish were seen in the entire Lake Clark district, and 40 bundles (1,600 salmon) were the greatest number any single fish village had dried. The only places where any numbers were reported were Taziminia and Kegik Rivers, but even there only a few fish had been dried. About 40 bundles (1,600 salmon) had been dried at Kegik and 24 bundles (960 salmon) at Taziminia, which comprised the major portion of all salmon reaching these streams. No salmon were seen along the lake shore, and on the Tarnalia Beach in the lake, near the mouth of Tarnalia Creek, there was a total failure, the first in 30 years to the knowledge of white men living there. These men endeavored to get the winter supply of salmon for themselves and dogs from Kegik, but had salted only 1¼ barrels in two weeks, after which they discontinued fishing. On the date of our visit (September 1) two families of natives were fishing, who took but one or two salmon a night from several nets set at advantageous locations in and near the mouth of the Kegik River.

On returning to Iliamna Lake the entire northern shore was prospected, comprising Chekok and Canyon Creeks, the Knutson Bay district, and the lakes scattered over Woody Islands. Most of these small streams carried a few salmon, notably Canyon and Knutson Creeks. About 100 red salmon were seen in the former and 150 in the latter stream. The possibilities of Knutson Creek are limited to a small spring pond near the creek entrance. The creek proper flows through light granite gravel; it continually changes its bed over about one-half mile of territory, has considerable fall, and has almost no spawning possibilities.

Along this northern shore the small size of the salmon was more noticeable than at the other points, as was also the large percentage of males. Many specimens in this vicinity measured from 14 to 17½ inches, and all were males. A set net placed overnight at Canyon Creek, where the salmon seen were spent, caught 2 medium-sized spent females and 38 males, 25 per cent of which were extremely small and the others medium. About 200 red salmon spawned in the Woody Islands Lakes. Many of the smaller streams contained more salmon than last year, although the numbers were small and aggregated far less; in fact, there were only about one-tenth as many fish as last year.

Summing up the escapement and results in this area, the outlook for the future of this run is discouraging. The escapement is the poorest in the history of the

fishery, according to old residents who have fished in the lakes for over 30 years. The natives had killed more than half of their sled dogs up to the time of our visit, and many more dogs will go before snow falls. In years of scarcity such as this the natives require for home use nearly all the salmon that escape the commercial fishermen, which results in the utter wiping out of the runs of some streams. This, together with the small size of the fish that filter through the commercial nets, which constituted most of the escapement and were mainly males, presents a most discouraging prospect. The natives and local residents of both Iliamna and Clark Lakes, after working over the entire spawning area, will probably cure about 30,000 red salmon, which is 20 per cent of the usual number. They contemplate centering their activities on trout fishing to supplement their winter food supply, and every encouragement was given them even to the extent of lending them some of our small gill nets.

WINTER WORK IN THE WOOD RIVER DISTRICT

Warden A. T. Looff and P. E. Hamm, engineer of the *Scoter*, were detailed to remain in the Bristol Bay district over the winter of 1925–26 to carry on certain investigations and look after the bureau's equipment. Mr. Looff's report on work during the fall and early winter is as follows:

At the close of commercial fishing in Bristol Bay on July 18 the patrol boats and other equipment not needed for fall work were taken to Naknek for winter storage at the bureau's marine ways. Immediately after arrival at Nushagak on August 14 the writer left for Aleknagik Lake with a power skiff. Headquarters were established at the mouth of the river entering Aleknagik Lake from Nerka Lake, from which point trips were made for the inspection of the spawning areas. The entire shore line and all tributary streams of Aleknagik Lake were visited and carefully examined.

At the time of the examination (August 15 to 27) practically all movement of red salmon up the river from Aleknagik Lake to the upper Wood River Lakes had ceased; hence it is thought that most of the salmon found in Aleknagik Lake at that time were resident fish. Large schools of salmon were at work in the gravel on the spawning beds around the mouth of the river entering Aleknagik Lake from Nerka Lake. Salmon had ascended each of the eight main streams tributary to Aleknagik Lake and were attempting to ascend in places where only a trace of water entered the lake. The salmon were concentrated mainly in the vicinity of the mouths of the tributary streams, but they were also spawning in practically all suitable gravel along the lake shore. The salmon were counted in the smaller tributary streams and along the lake shore, where they were not so numerous. Where many salmon were encountered, their numbers were estimated. It was estimated that 250,000 red salmon spawned in Aleknagik Lake and its tributaries this season.

During an examination of the Wood River lake system in 1922 it was estimated that 213,600 red salmon spawned in all of the lakes and that 32,000 of these spawned in Aleknagik Lake and its tributaries. If there was a proportionate escapement of salmon to the upper lakes this season, the total number must have been enormous.

EXAMINATION OF SNAKE RIVER LAKE

Leaving camp on Aleknagik Lake August 28 a trip was made with the power skiff by way of Nushagak Bay up Snake River to the rapids about 3½ miles below Snake River Lake. From this point to the lake the river was so shallow and swift that it was impossible to proceed with the boat and the trip was completed by walking. Spawning beds in the vicinity of the lake's outlet were examined. Large schools of red salmon were noted in the gravel along the southeast shore of the lake, and it was apparent that many red salmon had entered Snake River Lake. As but little work could be accomplished without a boat, it was decided to return to Nushagak for a native skin boat or "kyak," which could be portaged from the rapids to the lake. However, no such boat was available and the examination of the Snake River district was therefore discontinued. A further examination of the Snake River district will be made after the freeze-up, when overland travel will be possible. A report and description of the district will then be submitted.

OPERATIONS ON PREDATORY FISH

Upon returning from Snake River Lake to the camp on Aleknagik Lake (September 7), the destruction of predatory fish was taken up. Four trout gill nets, with mesh 3½ inches stretched measure, were set in eddies near the mouth of the river entering Aleknagik Lake from Nerka Lake. At first a little trouble was experienced from spawning salmon entering the nets, but they were frequently picked and the salmon released. Fair catches of Dolly Varden trout were made with the gill nets until the 1st of October, when the water of the lake began to rise rapidly.

Trips were made to various sections of the lake to prospect for trout. Several of the larger tributaries were examined but no concentration of trout was found, and the center of operations at the mouth of the river entering from Nerka Lake was never moved. Hand lines were tried at various times but with poor results. During the first part of October practically all salmon had disappeared, and drifts were made with one of the trout gill nets in the swift water where the river enters from Nerka Lake, but without success. During the latter part of September the water of the lake reached its lowest level for the season, but on the 1st of October heavy rains set in and the lake began to rise rapidly. With the rise of the water the catches of Dolly Varden trout fell off to almost nothing. On October 13 it had reached a level 6½ feet above the low-water mark, and, the weather having turned cold, operations were brought to a close. The writer returned to Nushagak and secured winter quarters at Dillingham, where the bureau's equipment was stored. As a result of fall work at Aleknagik Lake 1,325 Dolly Varden trout were destroyed, practically all of which were taken by set gill nets.

The stomachs of most of the Dolly Vardens taken were examined and their contents noted. During September the trout were feeding largely on salmon spawn, but toward the end of the month when the salmon-spawning season was about over the trout were feeding chiefly on the bodies of dead salmon. Again, during October the stomachs of trout taken contained salmon spawn. These trout were taken at the mouth of the river entering Aleknagik Lake from Nerka Lake when the river was at flood stage, and it is believed that they were feeding on salmon spawn washed down the river from nests broken up by the action of the water. The run of coho salmon on the lower river was reported to have been very poor. Very few silver salmon made their appearance at Aleknagik Lake. All terns disappeared from the lake about September 15, but great flocks of gulls were still there on October 13.

Five native families camped at the lake during the fall and fished for salmon, whitefish, and Dolly Varden trout. It was estimated that they put up about 1,000 red salmon. A prospector located at the head of Aleknagik Lake put up about 1,000 red salmon and 200 Dolly Varden trout for dog feed. Another prospector located on Nerka Lake, the second Wood River Lake, also reported putting up about 1,000 red salmon and 200 Dolly Varden trout for dog feed. No other fishing was done on the spawning grounds of the Wood River Lakes.

KUSKOKWIM RIVER

During the greater part of June, July, and August, Stream Guard Charles McGonagall was stationed on the Kuskokwim River to observe fishing operations. No violations of the fishery law and regulations were reported. Only two concerns fished outside the protected zone, all fishing in the river being for local use and not for export. Products of the salmon fishery were as follows: Kings, 32 tierces pickled and about 54,000 pounds dried; reds, 130 barrels pickled, 8,800 pounds of bellies pickled, and 263,000 pounds dried; and about 300,000 pounds of chums dried for dog feed. There were 24 whites and 196 natives engaged in the fishery. Apparatus in use consisted of 57 wheels, 202 gill nets of 3,050 fathoms, and miscellaneous small boats.

All commercial fishing for export from Alaska is prohibited after the 1925 season in Kuskokwim River and the waters off its mouth.

YUKON RIVER

All commercial fishing for export from Alaska was prohibited in the Yukon area in 1925. Fishing for local needs was carried on as usual, especially in the interior of Alaska, where salmon were dried for dog feed. Inspector C. F. Townsend and one stream guard were on duty at the fishing grounds during the season. There was a normal run of kings but apparently a shortage of chum salmon. The ice break-up caused more damage to wheels than usual and resulted in a smaller production of dried salmon; but owing to the large surplus carried over from the preceding year, there seemed to be a sufficient supply for the winter. To supplement the food supply whitefish can always be caught through the ice, and the eel run in the lower river never fails.

Products of the Yukon and Tanana fisheries were as follows: 144 barrels of red salmon and 21½ barrels of chums pickled, 71,200 pounds of kings, and 336,545 pounds of chums dried, and 212 cases of kings canned. Apparatus in use consisted of 168 wheels, 46 gill nets of 896 fathoms, 1 lighter, and a number of small boats. Approximately 27 whites and 174 natives were engaged in the fishery.

KARLUK SALMON COUNT

In 1925 a counting weir was erected on the Karluk River at about the same location as in 1924. Work was begun on May 10 and was completed a week later. Three traps were set above the weir to capture the predatory trout that gathered to prey on the young migrating salmon and to follow the ascending spawning salmon; 30,221 trout were captured in May and June, after which they disappeared and the traps were removed.

The first salmon passed through the weir on May 22, when both kings and reds began to ascend, and counting was continued until October 6. The total escapement during this period was 1,620,927 reds, 13,379 kings, and 15,445 cohos. Other species were not counted. Cohos and steelheads were still running when the weir was removed.

Commercial fishing off the mouth of the Karluk River was stopped from August 27 to 6 a. m. on September 7 because the catch exceeded the escapement. It was reported that 1,317,742 red salmon were caught in Karluk waters during the season, indicating that 45 per cent of the total run was caught and 55 per cent escaped to the spawning grounds. The commercial fishermen conducted an interesting experiment by marking (with white tape) and releasing 200 red salmon off the mouth of the river on August 1, to determine how promptly they ascend to the spawning grounds. The first fish reached the weir on August 4, when eight passed through, and they were noted continually until September 5. Fifty-nine fish in all were counted.

The work at Karluk was under the immediate supervision of Ray S. Wood, of the Afognak hatchery.

ALITAK SALMON COUNT

The weir at the upper station on Olga Bay was completed on May 21. The counting of red salmon began on May 29 and continued until October 1. The cannery station weir was completed on June 1 and counting began on June 4 and continued until October 5. At

the upper station 509,700 reds were counted and at the cannery station 40,910, a total of 550,610. In addition, 107 humpbacks and 21,699 cohos were counted through the weirs. These two species spawn chiefly in other waters, so that the counts at the above-mentioned racks should not be considered seriously in estimating the escapement.

Under the regulations commercial fishing in Alitak Bay was prohibited prior to June 15 in 1925. The run of red salmon was late and only very small catches were made up to the middle of July. All traps and beach seining for reds going into Olga Bay was stopped on August 4, as the commercial catch then exceeded the weir count, and fishing was not permitted again until August 14. Because of low water, the salmon ascended the creeks slowly. Commercial fishing in the bay was discontinued September 16, when the reported total catch of reds was 209,161, or about 28 per cent of the total run.

Homer H. Whitford was in charge of the counting and supervised commercial fishing operations.

CHIGNIK SALMON COUNT

A counting weir was erected on the Chignik River in 1925 at approximately the site used in 1924. The work was begun on April 28 and, in consequence of the extremely low water, which greatly facilitated the work, the rack was completed by May 20. The river at the rack is normally from 2 to 5 feet deep and 460 feet wide.

The first red salmon were seen to pass through the weir on June 4 and the last was counted on October 3. The total number of red salmon that escaped to the spawning grounds during that period was 1,063,930. At the beginning of the season the bureau directed that a minimum of 1,000,000 red salmon be allowed to escape, but in addition to this number, 919 kings and 53,561 cohos were counted through the rack. The king run lasted from June 18 to August 27, while the coho run began on August 12 and was virtually over when the counting of red salmon was discontinued.

The three companies that operated in this region began trap fishing on June 15 and stopped on September 10. Six traps were set in Chignik Bay and Lagoon, and one each in Aniakchak Bay, Hook Bay, and Kujulik Bay. The four lagoon traps were closed on July 24 because the commercial catch exceeded the escapement; the two traps in the bay were closed from August 8 to 17, inclusive, but permission was given to reopen them after August 17. Two of the lagoon traps were removed by the companies and the remaining two were reopened on August 24. The total number of red salmon caught in the nine traps was 697,774, about 40 per cent of the total run. Relatively small quantities of red salmon were taken in the three traps outside of the lagoon and bay, the cheaper grades of fish constituting the larger part of the catch there.

Migrating young salmon were noted going down river during the month of May, but there were no very large schools. A survey of the spawning grounds of the Chignik watershed was begun on September 22, and all important localities, with the exception of Black Lake, were visited. Large numbers of red salmon were observed spawning in almost all the rivers and creeks.

The season's operations were in charge of Warden Charles Petry.

ANAN SALMON COUNT

The counting of salmon that escape capture was begun in 1925 at Anan Creek in southeastern Alaska, where an important run of humpback salmon occurs. A weir was erected at a point midway between the two falls in the creek, where the latter was 180 feet in width. The rack was completed by June 5, and the first humpback salmon were counted through it on June 17. The run continued until September 8 and the total count was 261,339 humpbacks. In addition, 75 red salmon, 87 kings, 848 cohos, 140 chums, and 352 steelheads passed through the weir during that period. In comparison with this escapement, five traps operated a short distance below Anan Creek took 150,988 humpback salmon. Figures showing the catch by other kinds of apparatus in the same waters are not available.

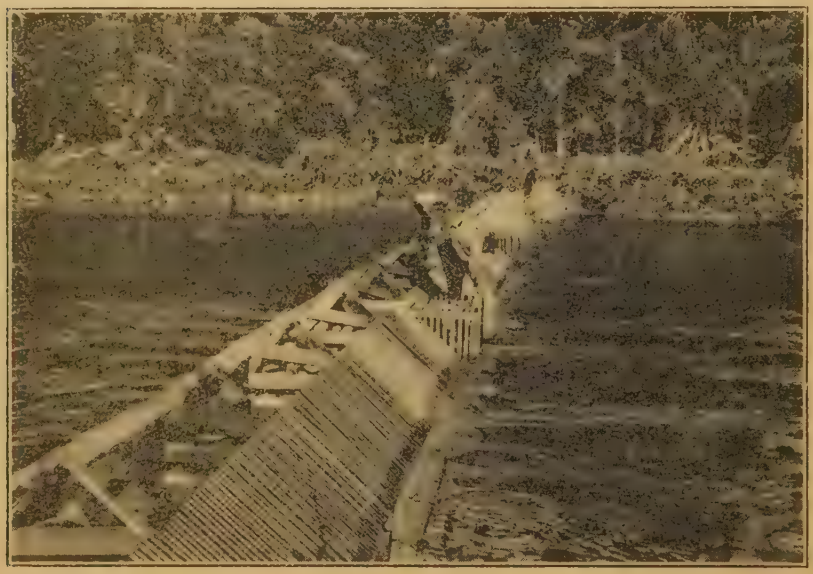

FIG. 4.—Salmon-counting weir at Anan Creek

John W. Gardner of the Yes Bay hatchery was detailed to supervise the construction of the weir, and Walter J. Larson later took charge of counting operations.

SALMON TAGGING

The tagging of salmon was continued in 1925 in southeastern Alaska and the Port Moller district for the purpose of obtaining further data with regard to the migration routes of these fish.

In southeastern Alaska the work was carried on in six general localities, and all species except the king salmon were handled. The numbers of salmon tagged at the various localities were as follows: Icy Strait, 1,384; Kingsmill Point, 1,944; Ruins Point, 3,243; Tree Point, 1,198; Cape Chacon, 2,759; and the west coast of Prince of Wales Island, 3,117; a total of 13,645 fish. Of these, 1,165 were red salmon, 2,394 chums, 8,544 humpbacks, and 1,542 cohos (including

1 king mistakenly tagged for a coho). Warden A. J. Suomela was in charge of the work, which continued from June 23 to August 22. Latest reports indicate that 4,722 salmon were recaptured, the tags having been returned for the reward of 50 cents offered for tags accompanied by information as to time and place of recapture. Analyses of the data are contained in another report.[2]

In the Port Moller district, off the mouths of the Bear and Sandy Rivers, 2,000 red salmon were tagged by Assistant Agent L. G. Wingard on July 1, 4, and 5. Of these, 949 were recaptured, all in the immediate vicinity except one reported taken at Naknek in Kvichak Bay.

SALMON LIFE-HISTORY STUDIES

In 1925, Dr. C. H. Gilbert, of Stanford University, again visited Alaska in connection with the studies of the life history of the Pacific salmons, which he has carried on for a number of years. He gave particular attention to the runs of red salmon in the Karluk and Chignik Rivers, and visited salmon canneries on the Alaska Peninsula in July.

Whenever conditions at Karluk would permit, scales were collected daily from 100 or more specimens, and from them the ages of the fish and the length of time that they remained in fresh water before proceeding to sea were determined. At Chignik similar collections were made two or three times a week, and the run was analyzed on the basis of this material. All scales taken at Karluk and Chignik in previous seasons have been examined and the results tabulated. Thus the foundation for further investigations of the runs in these two streams has been laid, investigations in which it will be possible to work with the records of escapements of known proportions. This is particularly true of the investigations to be conducted on the predominant year class at Karluk in 1926 and succeeding seasons.

OBSERVATIONS ON THE ESCAPEMENT OF SALMON

In accordance with the intent of Congress, as expressed in the act of June 6, 1924, that not less than 50 per cent of the salmon be allowed to escape to the spawning grounds, special attention was given to collecting data on the escapement in all districts. Special surveys were made, and all employees were instructed to report the conditions found in the localities where they were stationed.

Southeastern Alaska.—In the opinion of the guards stationed at all of the more important streams in southeastern Alaska, the escapement was adequate. Reports from persons in various localities in southeastern Alaska, including hunters, sport fishermen, and others, indicated that the escapements of spawning salmon were the best they had witnessed in years and reminded them of old times. In some places, where the catch was light as a result of restrictions placed on operations, or because certain areas had been closed to fishing, the runs (especially of humpbacks and chums) were good and the escapement was correspondingly large.

A special item on the escape of salmon in Anan Creek is to be found elsewhere in this report. Agent Dennis Winn and Warden M. J. O'Connor visited Chilkat and Chilkoot Lakes on July 31 and

[2] Salmon-tagging Experiments in Alaska, 1924 and 1925, by Willis H. Rich. Bulletin, U. S. Bureau of Fisheries, Vol. XLII, 1926, Document No. 1005, pp. 109–146. Washington.

August 1. It was then too early to observe the full extent of spawning, but a few red salmon were seen in the lakes and in the small creeks flowing into them. The chief purpose of the trip was to determine the practicability of erecting counting racks at the outlets of the lakes. They are of glacial origin, and the water was found to be so turbid that the fish could not be seen clearly enough to be counted. Mr. O'Connor again visited the Chilkoot district on October 2 and 3 and reported a good escapement of red salmon to the spawning grounds in the lake, upper river, and tributary creeks.

Prince William Sound district.—A trip up the Copper River and its tributaries was made by Howard H. Hungerford from July 10 to September 6, for the purpose of collecting data in regard to the escapement of red and king salmon to the spawning beds of the Copper River system. Apparently there had been a very good escapement of king salmon, but in some places the red salmon had failed to appear and in many others they came in smaller numbers than usual. These conclusions were confirmed by the results of commercial fishing off the Copper River, where the pack of red salmon equaled only a small fraction of the quantities packed in previous years. As a result of additional restrictions on operations this year, there was a very satisfactory escapement of salmon to spawning grounds of streams in Prince William Sound proper.

Cook Inlet district.—Stream guards visited the spawning grounds of streams entering English Bay and Chinik Inlet. An excellent escapement was reported at English Bay, where ascent was easy; but it was observed that not more than one-third of the salmon that attempted to ascend Chinik Creek could pass the falls and reach the spawning grounds. A channel over these falls will be constructed. A large number of red salmon entered the Kenai and Kasilof Rivers. Considerable work was done to facilitate the ascent of salmon in streams in this district, and in this connection, with the approval of the Bureau of Biological Survey, a number of beaver dams were destroyed.

Alaska Peninsula district.—Assistant Agent L. G. Wingard, who had charge of the Alaska Peninsula district, made careful observations of the salmon escapement in all the principal streams in the region. Compared with the size of the run during the season, which was considered to be below average, a fair escapement occurred in every locality. As it was the offyear for humpback salmon, there was virtually no run of that species in the district. A special investigation of the lakes at the head of the Bear and Sandy Rivers was made from August 18 to 23. These lakes receive a large part of the red-salmon run in the Port Moller district. Mr. Wingard's report on the investigation is as follows:

> We made two trips to the mouth of the Bear River from Port Moller on the gas boat *Auk*, and on the second trip (August 17) the boat crossed the bar and entered the inner channel without mishap. A three-quarters size eastern dory, equipped with a Johnson outboard motor, was used to ascend the river, and 12 hours were required to reach the lake. Owing to its draft, the dory occasionally struck sand bars and riffles, which delayed its progress.
>
> On reaching Bear Lake (August 18), a base camp was established near the outlet close to two old barrabaras (native huts) and several fish racks. From this base the survey of the lake was made, and later the trip to Sandy Lake.
>
> Bear Lake was examined on August 19. We made a circuit of the lake in the dory and stopped at numerous small creeks and spawning areas. Three streams of importance flow into Bear Lake. Red salmon ascend these streams

for considerable distances and spawn in them and off their mouths. About 50,000 red salmon escaped into the lake, but no other species was observed there or in the tributary creeks. The absence of trout and other enemies of the salmon was especially noticeable. Trout were present in large numbers in the river below the lake, from the point where Mill Creek enters it and the water becomes clear. They appeared to be feeding on the spawn of humpback and chum salmon. Chum salmon were plentiful in the river.

Starting at the outlet and following the right shore line, we encountered a moderate-sized school of red salmon a short distance from the outlet. The bed on which the salmon were spawning was seeded to not more than one-fifth its capacity, but it appeared that only about 75 per cent of the fish in the school were spawning.

The first stream of importance was found midway of the lake shore. After walking up this stream and counting and observing fish in various areas, we estimated the escapement into the stream to be 3,700 fish. A second stream, that entered the lake a little nearer the head and formed a point that extended into the lake, was examined in like manner, and 4,800 spawning fish were counted. These two streams could easily accommodate 15,000 salmon throughout their length and about their mouths. In the stream that enters the head of the lake—the most important in the Bear Lake area—there were about 13,000 spawning salmon. It could easily support 30,000, as it flows over a large flat and has numerous channels suitable for spawning. At the present time this stream enters the lake in two main channels, but there are two channels of dead water, as well, which formerly flowed into the lake.

Returning along the left shore, we observed a few fish in the mouths of the small creeks. They were scattered, and about halfway up this shore they disappeared entirely, and we saw no more until the outlet of the lake was reached.

There was a large school of fish at the outlet of the lake. After a careful survey the number of fish was estimated to be between 23,000 and 25,000. They were finning and playing for a distance of about 150 yards up the river from its outlet into the lake, the outlet being 50 feet wide, and the school extended out into the lake and along both shores for about 100 yards. The fish in the lake were not spawning, but a few in the stream were. However, most of them seemed to be awaiting ripening before going to the spawning beds in the lake. The spawning areas in the lake that were not in the immediate vicinity of large streams together received an escapement of from 5,000 to 6,000 fish. The total escapement into Bear River Lake amounted to a little over 50,000 fish.

We started for Sandy River Lake on August 20, and 10½ hours were consumed in making the trip from lake to lake. Traveling was difficult owing to a downpour of rain, and the streams were running bank full and the flats were covered with sheets of water.

On the following day (August 21) we surveyed the Sandy River Lake spawning beds. At the outlet, a small school of fish estimated to contain 6,000 fish, was observed to be acting like those at the outlet of Bear Lake. Following the right shore line, we counted 1,200 fish in the first stream of importance, 4,000 in and about the mouth of the second stream, and about 800 in a large stream at the head of the lake on the farther side. Two small streams enter the lake at its head, between the two larger ones, but few salmon were seen in them. The water was very high and full of sediment, because of the torrential rains, and it was difficult to make estimates. We explored the northern shore of the lake without seeing more than 200 salmon. Small schools that were spawning here and there, together with a school of about 2,000 between the creeks mentioned above, numbered in all about 6,000 fish, making the escapement of salmon in Sandy River Lake just over 17,000, or about one-third that of Bear River Lake.

We returned to Bear River Lake on August 22 in a little less than 10 hours. It was raining still, and traveling was very difficult. For the return down Bear River on the following day, two hours were required, and as the sea was smooth and there was no swell on the beach the party went on to Port Moller.

The greatest problem confronting a party wishing to make the Bear and Sandy River Lakes trip is how to enter and leave Bear River. The beach is open and exposed to all winds except the east and southeast. Often natives wishing to enter the river must wait for a week in the summer, and after the first of September it is not uncommonly necessary to wait for a month, while at other times the weather may be fine.

In the future it would be advisable to land equipment and necessary food supplies during the summer, when the storms are of short duration and when the swell subsides quickly enough to permit a satisfactory landing. Then, in the fall, if weather conditions are unsatisfactory, one may walk along the beach to the

mouth of the Bear River and ascend the river from the village situated there. Instead of walking the long distance across flats, creeks, and low ridges between Bear and Sandy Lakes, one should return to the village at the mouth of the river and ascend Cole Creek, which enters Bear River near its mouth. Cole Creek is deep enough to float a boat, but is not as wide as Bear River and meanders more. It is a little longer than Bear River, though not as swift, and probably can be ascended as quickly. From Cole Creek one may walk to Sandy Lake in about three hours. By ascending Cole Creek, it will require only two men to make the trip, and the necessity for an additional packer is obviated. Sandy River is too shallow to be negotiated by boat or canoe, and even though ascent were easy it would be impracticable, as the weather conditions before mentioned might delay landing.

The weather is fairly reliable during August, but not all the fish are on the spawning beds as early as is convenient for conducting investigations. Late August and early September are the best times for making surveys, as the fall rains deepen the streams, aiding ascent, and the fish are then ripe. A canoe equipped with an outboard motor bracket and capable of carrying about 800 pounds without drawing more than a foot of water is the most practicable means of ascending these rivers.

Bristol Bay district.—Agent Dennis Winn made a trip over the Iliamna and Lake Clark spawning areas during the latter part of August and the 1st of September. He reported that the escapement was the poorest in the history of the industry and that the ascending fish were of unusually small size. Natives in the vicinity had been unable to secure enough salmon for their winter food supply, and more than half of their sled dogs already had been killed because of the shortage of food.

Although the escapement of red salmon to tributary waters on the eastern side of Bristol Bay was poor, the situation was much better with respect to Nushagak Bay tributaries, where investigations by Warden A. T. Looff of the Wood River and Snake River systems showed that there was a good escapement of salmon to the spawning grounds. The reports of both Agent Winn and Warden Looff are printed in full elsewhere in this document.

HATCHERIES

EXTENT OF OPERATIONS

Salmon propagation in Alaska, exclusive of Territorial activities, was carried on at the Government's hatchery at McDonald Lake and at two other hatcheries—one owned by the Alaska Packers Association at Heckman Lake and the other by the Northwestern Fisheries Co. at Hugh Smith Lake. Operations were resumed at the Government's hatchery at Afognak, also, where red-salmon eggs were collected in the fall.

Operations of Federal and private hatcheries in Alaska in 1925

Location of hatchery	Red or sockeye salmon		
	Eggs taken in 1924	Salmon liberated in 1924–25	Eggs taken in 1925
Afognak			11,000,000
McDonald Lake	30,080,000	27,382,000	[1] 39,680,000
Heckman Lake (Fortmann) [2]	11,640,000	11,005,000	16,920,000
Hugh Smith Lake (Quadra)	20,050,000	19,430,000	20,240,000
Total	61,770,000	57,817,000	87,840,000

[1] Shipped 8,645,760 eyed red-salmon eggs on Nov. 20, 1925, of which 5,645,000 went to the bureau's hatchery at Baker Lake, Wash., and the remaining 3,000,760 to the Oregon State Fish Commission.

[2] At the Fortmann hatchery, 805,000 humpback-salmon fry were released in 1924–25, and 4,680,000 eggs of this species were taken in 1925.

AFOGNAK

The rebuilding of the Federal hatchery at Afognak was finished in time to collect eggs during the season of 1925. Spawning operations began on August 3 and continued to September 15, during which time 11,000,000 red-salmon eggs were taken. Fry were not distributed during the year as no eggs were collected in 1924. Attention was given to the destruction of predatory trout, which are abundant in Litnik Lake and are believed to be mainly responsible for the decline of the run of salmon. From July to December, 54,100 Dolly Varden trout were taken in traps and beach seines.

M'DONALD LAKE

At the Federal salmon hatchery on McDonald Lake, 27,382,000 red-salmon fry were hatched from 30,080,000 eggs taken in 1924, a loss of about 9 per cent, and these were liberated later as fry and fingerlings. Extreme cold weather and the partial freezing of the water supply in December and January necessitated the planting of 6,300,000 fry in order to avoid losing them. All other plants consisted of No. 1 and No. 2 fingerlings, and were made from June to October.

In the period from September 7 to October 6, 1925, 39,680,000 red-salmon eggs were taken. On November 20, a shipment of 8,645,760 eyed eggs was made, 5,645,000 to the bureau's station at Baker Lake, Wash., and the remaining 3,000,760 to the Oregon State Fish Commission.

HECKMAN LAKE (FORTMANN)

The Alaska Packers Association liberated 11,005,000 red-salmon fry from its Fortmann hatchery on Heckman Lake in 1925, which were hatched from 11,640,000 eggs taken in 1924, a loss of 5.45 per cent. In addition, 805,000 humpback-salmon fry, hatched from eggs collected in 1924, were released. Egg taking began on September 5 in 1925 and ended on November 16, during which time 16,920,000 red-salmon eggs and 4,680,000 humpback-salmon eggs were taken.

HUGH SMITH LAKE (QUADRA)

The Northwestern Fisheries Co. liberated 19,430,000 red-salmon fry from its hatchery near Boca de Quadra in 1925, hatched from 20,050,000 eggs taken in 1924, a loss of 3 per cent. In 1925, the hatchery was filled to capacity with 20,240,000 red-salmon eggs taken from August 7 to September 9.

TERRITORIAL HATCHERIES

Under date of March 29, 1926, Patrick Gildea, secretary of the Alaska Territorial Fish Commission, submitted a general outline of the commission's fish-cultural work in Alaska in 1925, as follows:

Hatchery operations.—At the Ketchikan hatchery, 1,930,000 chinook-salmon fingerlings were reared, which were liberated in August. These were hatched from 2,000,000 eggs that were obtained in 1924 from the State of Washington. Ten thousand of these chinook fingerlings were marked by removing the dorsal and adipose fins. Some of these fry are still in Ketchikan Creek. From 3,477,000 eggs taken in 1924, 2,946,000 humpback-salmon fingerlings were produced. Most of these were taken to the salt-water feeding pond at Ponds Bay, Duke Island. They did very well for a time and were liberated during the latter part of March,

as the fence did not hold, in consequence of the heavy flood tides. Preparations are being made to hold and feed several million humpback-salmon fry in 1926.

At the Snag Harbor, Gravina Island, feeding pond, a small number of humpback-salmon fry were held and fed, and 8,180 were marked by removing the right ventral and adipose fins.

From 2,640,000 chum-salmon eggs taken at Walker's Cove in 1924, 2,501,000 fry were hatched and liberated as fingerlings in Ketchikan Creek.

The egg take this year consisted of 11,415,000 humpback, 320,000 chum, and 165,000 red-salmon eggs; and 2,000,000 chinook-salmon eggs were secured from the State of Washington.

At the Cordova hatchery, 3,242,150 red-salmon fry were hatched from 5,250,000 eggs collected in 1924, and later were liberated. From 571,000 chinook-salmon eggs secured in 1924 from the State of Washington, 523,500 fry were hatched. In 1925, the number of red-salmon eggs collected was 7,530,300, which produced 7,318,455 fry.

The 1,429,000 chinook-salmon eggs secured in 1924 from the State of Washington for the Seward hatchery on Grouse Lake produced 1,387,000 fingerlings,

FIG. 5.—Salt-water feeding inclosure for humpback-salmon fry near Ketchikan

which were liberated; and 846,360 red-salmon fingerlings, the result of hatching 1,015,000 eggs taken in 1924, were liberated in Grouse Lake. In 1925, 4,460,544 red-salmon eggs were collected. By December 31 about 1,000,000 fry hatched from these eggs had reached the free-swimming stage, and 3,189,666 still retained the egg sack.

Weir operations.—At Grouse Lake, 651 red salmon and 758 cohos were counted through the weir, and 3,057 trout were destroyed at Grouse and Bear Lakes. At Bear Lake, 41,000 red salmon passed through and were counted. At Robe Lake, Valdez, 12,265 reds, 415 cohos, 27 humpbacks, and 34 chums were counted through the weir and 13,365 trout were destroyed. At Eshamy, 5 kings, 16,448 reds, 1,523 cohos, and 224 humpbacks were counted and 406 trout were destroyed. At the Eyak Lake weir, 24,778 red salmon passed through and were counted, and 11,287 trout were destroyed.

TROUT OPERATIONS

During the season of 1925 the department of fisheries and game of the State of Washington operated a station at Eva Lake, in southeastern Alaska, for the collection of cutthroat-trout eggs. The total

collection of eggs was 133,000, from which 85,000 eyed eggs were shipped to the State of Washington and 19,500 fry were delivered to a representative of the Forest Service at Sitka for stocking local streams.

HATCHERY REBATES

The owners of private salmon hatcheries in Alaska, who are also packers of canned salmon, receive a rebate on license fees and taxes of every nature on their catch and pack of salmon at the rate of 40 cents per 1,000 king or red salmon fry liberated by them in Alaskan waters.

Rebates credited to private salmon hatcheries, fiscal year ended June 30, 1925

Owner	Location	Red-salmon fry liberated	Rebate due
Alaska Packers Association	Heckman Lake	11,005,000	$4,402
Northwestern Fisheries Co	Hugh Smith Lake	19,430,000	7,772
Total		30,435,000	12,174

GENERAL STATISTICS OF THE FISHERIES

The total number of persons engaged in the fisheries of Alaska in 1925 was 27,685, or 2,491 more than in 1924. The total investment in the fisheries was $67,077,495, an increase of 7 per cent. The investment in the salmon industry was $55,402,007, an increase of $768,828 over 1924. The products of the fisheries were valued at $40,038,745, a decrease of $250,528, or 0.6 per cent.

Summary of persons engaged, investment, and products of the Alaska fisheries in 1925

Items	Southeast Alaska		Central Alaska		Western Alaska		Total	
PERSONS ENGAGED	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*
Whites	7,061		3,876		5,059		15,996	
Natives	2,893		1,035		679		4,607	
Chinese	440		257		581		1,278	
Japanese	867		428		253		1,548	
Filipinos	1,293		447		506		2,246	
Mexicans	146		83		1,281		1,510	
Negroes	4		24		227		255	
Porto Ricans	11		3		136		150	
Miscellaneous	45				50		95	
Total	12,760		6,153		8,772		27,685	
INVESTMENT								
Salmon canning		$25,625,640		$11,940,888		$15,977,016		$53,543,544
Salmon mild-curing		1,389,342		109,083				1,498,425
Salmon pickling				46,531		156,469		203,000
Salmon, fresh		10,861						10,861
Salmon, drying, smoking, and dry-salting						25,196		25,196
Salmon by-products		120,981						120,981
Halibut fishery		3,444,327		59,594				3,503,921
Herring fishery		2,726,360		3,363,644		18,490		6,108,494
Cod fishery				450,075		17,455		467,530
Clam fishery				672,244				672,244
Crab fishery		59,872						59,872
Shrimp fishery		318,353						318,353
Whale fishery				11,000		534,074		545,074
Total		33,695,736		16,653,059		16,728,700		67,077,495

Summary of persons engaged, investment, and products of the Alaska fisheries in 1925—Continued

Items	Southeast Alaska		Central Alaska		Western Alaska		Total	
PRODUCTS								
Salmon:	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*
Canned ..... cases	2,802,414	$15,751,204	1,052,593	$8,667,467	604,930	$7,570,860	4,459,937	$31,989,531
Mild cured ..... pounds	5,045,600	1,052,488	172,000	32,978			5,217,600	1,085,466
Pickled ..... do	94,900	9,130	229,200	24,765	305,500	50,836	629,600	84,731
Fresh ..... do	2,620,017	223,907					2,620,017	223,907
Frozen ..... do	2,572,623	170,663					2,572,623	170,663
Dried, smoked, and dry-salted ..... pounds	5,200	582	18,100	1,338	1,024,745	124,545	1,048,045	126,465
Fertilizer ..... do	1,074,000	31,990	358,625	9,817			1,432,625	41,807
Oil ..... gallons	26,500	11,950	14,180	6,380			40,680	18,330
Halibut:								
Fresh ..... pounds	3,231,214	300,008	18,015	1,992			3,249,229	302,000
Frozen ..... do	6,405,864	513,058	1,316,558	69,325			7,722,422	582,383
Herring:								
Fresh for bait ..... do	2,821,750	17,661	30,000	450			2,851,750	18,111
Frozen for bait ..... pounds	4,235,090	21,315					4,235,090	21,315
Pickled for food—Scotch cure ..... pounds	4,641,625	307,063	29,243,190	1,960,514	41,160	3,000	33,925,975	2,270,577
Norwegian cure ..... pounds	232,000	14,770	133,225	8,199			365,225	22,969
Spiced ..... do	10,200	1,200					10,200	1,200
Bloaters ..... do			190,575	7,660			190,575	7,660
Dry-salted ..... do	273,000	3,660	404,705	16,314			677,705	19,974
Canned ..... do			1,824	150			1,824	150
Fertilizer ..... do	15,176,646	438,468	1,995,381	52,980			17,172,027	491,448
Oil ..... gallons	2,061,398	870,589	289,754	128,456			2,351,152	999,045
Cod:								
Dry-salted ..... pounds			2,551,164	108,783	178,685	10,721	2,729,849	119,504
Stockfish ..... do			36,718	7,226			36,718	7,226
Tongues ..... do			1,750	170			1,750	170
Frozen ..... do	75,225	1,128					75,225	1,128
Pickled ..... do	10,400	775					10,400	775
Whale:								
Oil ..... gallons					848,850	509,310	848,850	509,310
Sperm oil ..... do					114,400	46,637	114,400	46,637
Fertilizer ..... pounds					2,444,000	57,299	2,444,000	57,299
Pickled meat ..... do					127,149	6,113	127,149	6,113
Carcasses ..... do			670,000	5,600			670,000	5,600
Clams ..... cases	5,088	33,672	70,191	458,379			75,279	492,051
Shrimp ..... pounds	519,535	207,315					519,535	207,315
Crabs:								
Canned ..... cases			87	600			87	600
Meat ..... pounds	124,805	49,185					124,805	49,185
Whole in shell ..... dozen	2,200	3,572					2,200	3,572
Trout:								
Fresh ..... pounds	31,809	4,641					31,809	4,641
Frozen ..... do	8,805	524	11,538	912			20,343	1,436
Pickled ..... do			1,000	60			1,000	60
Sablefish:								
Fresh ..... do	190,517	7,477					190,517	7,477
Frozen ..... do	731,912	30,971					731,912	30,971
Pickled ..... do	120,096	6,388					120,096	6,388
Rockfishes ..... do	23,936	490					23,936	490
Smelt ..... do	23,420	2,342					23,420	2,342
"Lingcod" ..... do	30,736	615					30,736	615
Flounders ..... do	10,835	108					10,835	108
Total		20,088,909		11,570,515		8,379,321		[1]40,038,745

[1] These figures represent the value of the manufactured product. It is estimated that the value of the catch to the fishermen was approximately $9,860,000. The round weight of the salmon landed by the fishermen was about 381,035,010 pounds, and the corresponding figure for herring was about 180,000,000 pounds. The cod figures given above do not include the offshore catch in waters adjacent to Alaska, which amounted to 10,541,146 pounds of dry-salted cod and 19,400 pounds of tongues, having a total value of $573,170, landed at ports of the Pacific Coast States.

SALMON

In 1925 the catch of salmon in Alaska as a whole showed a decline of 19 per cent from that of 1924, chiefly because of the small run of humpback salmon that occurs in central Alaska in alternate years, and secondarily because of the smaller number of red salmon taken

in western Alaska. In southeastern Alaska the catch increased 3.6 per cent, while that in the central district declined 45 per cent, and in western Alaska 31 per cent. As soon as it became apparent that the run of red salmon in the Bristol Bay district would be small, the fishing season was curtailed, which resulted in a smaller catch than otherwise would have been made. The total catch in southeastern Alaska was swelled mainly by the large number of chum salmon taken by the various canneries, which were in operation for a longer period than usual in the fall of 1925.

The number of independent traps operated in southeastern Alaska rose from 54 in 1924 to 95 in 1925. This augmentation of numbers was chiefly responsible for the increase in the proportion of the catch by traps from 57 per cent of the total catch in southeastern Alaska in 1924 to 64 per cent in 1925. The increase in both traps and

FIG. 6.—Salmon cannery on Bristol Bay

catch took place mainly in the southern part of the district, as north of 58° north latitude the distance between traps had been extended by departmental regulation from 1,800 feet to 1½ miles, which resulted in a reduction in the number of traps employed from 77 in 1924 to 56 in 1925, or 27.2 per cent, and a decrease of 967,501 in the number of salmon caught in the Icy Strait-Cross Sound region.

CATCH AND APPARATUS

The total number of seines used in the salmon industry of Alaska in 1925 was 518, of which 96 were beach seines and 422 were purse seines. The beach seines aggregated 13,085 fathoms of webbing and the purse seines 72,057 fathoms. The number of gill nets used was 3,382, having a total length of 340,901 fathoms. There were 290 driven traps and 256 floating traps, a total of 546.

Southeastern Alaska is credited with 383 seines, or a total of 65,067 fathoms of webbing, an increase of 75 seines, or 13,368 fathoms, over the number used in 1924; also with 190 gill nets, aggregating 20,871 fathoms, a reduction of 11 nets but an increase of 3,476 fathoms when compared with the quantity used in the previous season; and

with 158 driven and 248 floating traps, 18 fewer driven traps but 73 more floating traps than were operated in 1924.

Corresponding figures for central Alaska show 125 seines, or 17,575 fathoms, as compared with 115 seines, or 16,835 fathoms, in 1924; 855 gill nets, or 47,484 fathoms, compared with 799 gill nets, or 52,290 fathoms, in 1924, showing an increase of 56 nets, but a decrease of 4,806 fathoms. The number of traps operated was 128 driven and 8 floating, as compared with 97 and 5, respectively, in 1924.

In western Alaska 10 seines, or 2,500 fathoms of webbing, were used, an increase over the number shown in 1924 of 6 seines, or 2,000 fathoms of webbing. A total of 2,337 gill nets was used, having an aggregate length of 272,546 fathoms, an increase of 421 nets, or 28,946 fathoms, in the quantity of webbing used. Four driven traps were operated, one less than in 1924.

FIG. 7.—Purse seine surrounding school of salmon

Seines caught 30 per cent of the salmon taken in 1925, gill nets 15 per cent, and traps 53 per cent, while lines and wheels took the remaining 2 per cent.

Percentage of salmon caught in each Alaska district, by principal forms of apparatus

Apparatus	Southeast Alaska		Central Alaska		Western Alaska	
	1924	1925	1924	1925	1924	1925
Seines	38	32	35	42	8	3
Gill nets	3	2	5	4	81	91
Traps	57	64	60	54	2	2
Lines	2	2				
Wheels					8	4

The total catch of salmon in 1925 was 64,246,391, a decrease of 15,231,209, or 19 per cent, from the number taken in 1924. South-

eastern Alaska showed a gain of 1,396,801, while in central and western Alaska a falling off of 12,382,960 and 4,245,050, respectively, was shown. The catch by species shows that cohos increased 89,159, chums 2,787,281, and kings 22,315; while humpbacks decreased 14,394,500, and reds 3,735,464.

Salmon taken in 1925, by apparatus and species, in each geographic section of Alaska

Apparatus and species	Southeast Alaska	Central Alaska	Western Alaska	Total
Seines:				
Coho, or silver	93,043	126,643		219,686
Chum, or keta	5,039,047	802,745	13,104	5,854,896
Humpback, or pink	7,156,192	3,966,411	3,842	11,126,445
King, or spring	1,902	2,510	5,288	9,700
Red, or sockeye	301,798	1,439,901	221,370	1,963,069
Total	12,591,982	6,338,210	243,604	19,173,796
Gill nets:				
Coho, or silver	246,359	217,542	17,436	481,337
Chum, or keta	37,563	24,387	365,040	426,990
Humpback, or pink	129,161	61,693	18	190,872
King, or spring	39,772	28,892	114,029	182,693
Red, or sockeye	255,089	363,976	8,005,992	8,625,057
Total	707,944	696,490	8,502,515	9,906,949
Traps:				
Coho, or silver	546,733	430,840		977,573
Chum, or keta	3,561,556	1,327,132	40,770	4,929,458
Humpback, or pink	20,301,051	3,127,827		23,428,878
King, or spring	14,878	52,975	5,262	73,115
Red, or sockeye	1,257,229	3,152,183	185,527	4,594,939
Total	25,681,447	8,090,957	231,559	34,003,963
Lines:				
Coho, or silver	298,217			298,217
Chum, or keta	3,209			3,209
Humpback, or pink	648			648
King, or spring	524,664			524,664
Red, or sockeye	292			292
Total	827,030			827,030
Wheels:				
Coho, or silver			100	100
Chum, or keta			264,394	264,394
King, or spring			26,443	26,443
Red, or sockeye			43,716	43,716
Total			334,653	334,653
Total:				
Coho, or silver	1,184,352	775,025	17,536	1,976,913
Chum, or keta	8,641,375	2,154,264	683,308	11,478,947
Humpback, or pink	27,587,052	7,155,931	3,860	34,746,843
King, or spring	581,216	84,377	151,022	816,615
Red, or sockeye	1,814,408	4,956,060	8,456,605	15,227,073
Grand total	39,808,403	15,125,657	9,312,331	64,246,391

CANNING

CHANGES IN CANNERIES

The A. & P. Products Corporation, which operated four canneries in southeastern Alaska in 1924, organized a subsidiary company, under the name of the Nakat Packing Corporation, to carry on its salmon operations in Alaska. The Hoonah Packing Co. reopened its plant at Gambier Bay, which was closed in 1924. The Northland Packing Co. leased and operated the plant of the Sunrise Packing Co.

at Ketchikan. The Point Warde Fisheries Co. changed its name to Point Warde Fisheries. The Sebastian Stuart Fish Co. operated the Tyee plant, which they purchased from the Alaska Salmon & Herring Packers in 1924.

The Alaska Year-Round Canneries Co. and the Cook Inlet Packing Co., which operated jointly at the former's plant in 1924, conducted independent operations in 1925. The machinery of the Henry J. Emard plant at Moose Point was set up in the Anchorage plant of Gorman & Co., which was opened in 1925. The Hemrich Packing Co., which operated as a salmon and clam cannery at Kukak Bay in 1924, leased its plant to the Seashore Packing Co. in 1925. The International Packing Co. operated its floating cannery at Makushin Bay, in western Alaska, and Kiliuda Bay, in the central district, after fishing was discontinued at Ugashik River on Bristol Bay. A newly organized concern, the Orca Packing Co., purchased and operated at Cordova the floating plant of the Hayes-Graham Fish Co., which has been operated at various times under the names Star Canning Co. and Copper River Canning Co.

NEW CANNERIES

During the winter the Cook Inlet Packing Co. built a small one-line cannery at Seldovia and operated independently for the first time in 1925. W. A. Keller opened a small hand plant at Deep Creek, on Cook Inlet, for the canning of salmon and clams. The Nakat Packing Corporation purchased the salmon saltery of Peter M. Nelson on Kvichak Bay, Bristol Bay, and converted it into a cannery. New structures, in knock-down form, were taken to this location (which has been named Nakeen), and the erection of the plant was completed in time for the season's operation.

CANNERIES NOT OPERATED

The Tee Harbor plant of the Alaska Consolidated Canneries and the Wrangell plant of the Alaska Sanitary Packing Co., which were burned in 1924, were not rebuilt in time to be operated in 1925. Both companies fished traps and sold the catch. The Haines Packing Co., at Haines, was not operated, the reason given being that the closure of the upper part of Lynn Canal to salmon fishing prevented the taking of sufficient salmon to warrant operating the plant. P. E. Harris & Co., who operated the G. W. Hume plant at Scow Bay in 1924, did not renew the lease in 1925. The machinery was put into the F. C. Barnes plant, which was rebuilt at Lake Bay in the spring of 1925. The Pyramid Packing Co. did not operate as a separate unit the plant of the Sitka Packing Co., which it took over in 1924 and consolidated with its own plant at that place. The Pavlof Harbor plant, which was operated last by Carlson Bros., has been dismantled and the machinery disposed of. The Carlson Fish Co. limited its operations to trap fishing during 1925. The plants of the American Packing Co. at Juneau, Auk Bay Salmon Canning Co., and John L. Carlson & Co. at Auk Bay, and the Deep Sea Salmon Co. at Ford Arm are reported to have been partly dismantled and probably will not be reopened, hence they are included no longer in the list of idle salmon canneries.

The Arctic Packing Co. did not operate its cannery at English Bay but cured herring exclusively. The plant of the Alaska Sea Food Co. was sold to the Warrenton Clam Co. and used as a receiving and weighing station. The Kodiak Island Fishing & Packing Co.'s salmon cannery at Seward was not operated. Pajoman & Trout, who prepared a small pack of salmon at Raspberry Island in 1924, did no canning in 1925.

The following canneries were closed during the season but may be reopened:

Southeastern Alaska:
- Alaska Sanitary Packing Co—Cape Fanshaw.
- Haines Packing Co—Haines.
- Hoonah Packing Co—Hoonah.
- Northwestern Fisheries Co—Roe Point. Santa Ana.

Central Alaska:
- Alaska Packers Association—Kasilof.
- Arctic Packing Co—English Bay.
- Bainbridge Fisheries Co—Flemming Island.
- Kamishak Packing Co—Kamishak Bay.
- Kodiak Island Fishing & Packing Co—Seward.
- Northwestern Fisheries Co—Seldovia. Orca.
- Pajoman & Trout—Raspberry Island.

Western Alaska:
- Alaska Salmon Co—Kvichak Bay.
- Fidalgo Island Packing Co—Herendeen Bay.
- Nelson Lagoon Packing Co—Nelson Lagoon.
- Phoenix Packing Co—Herendeen Bay.

TOTAL CANNERIES OPERATED

There were 129 canneries operated in Alaska in 1925, 62 in southeastern, 37 in central, and 30 in western, which was 3 less for southeastern and 2 more in western than in 1924, a net loss of 1 plant. One floating cannery was operated in both the western and central districts but is credited to the western.

Companies that can salmon in Alaska, number and location of canneries operated, and number of traps owned by each, 1925

[New canneries indicated by (*)]

Company	Canneries		Traps		
	Number	Location	Driven	Floating	Total
Southeast Alaska:					
Alaska Consolidated Canneries	6	Boca de Quadra	2	5	7
		Chomly	2	3	5
		Pybus Bay	4	3	7
		Rose Inlet	1	6	7
		Tenakee	6	5	11
		Yes Bay	2	6	8
Alaska Herring & Sardine Co	1	Port Walter	2	3	5
Alaska Packers Association	2	Loring	5		5
		Wrangell		7	7
Annette Island Packing Co	1	Metlakatla	6		6
Astoria & Puget Sound Canning Co	1	Excursion Inlet	3	2	5
F. C. Barnes Co	1	Lake Bay	1		1
Bayview Packing Co	1	Bay View			
Beauclaire Packing Co	1	Port Beauclerc			
Beegle Packing Co	1	Ketchikan	2	2	4
Burnett Inlet Packing Co	1	Burnett Inlet		5	5
Deep Sea Salmon Co	1	Port Althorp		13	13

Companies that can salmon in Alaska, number and location of canneries operated, and number of traps owned by each, 1925—Continued

Company	Canneries		Traps		
	Number	Location	Driven	Floating	Total
Southeast Alaska—Continued.					
Charles W. Demmert Packing Co	1	Bay View		1	1
Douglas Island Packing Co	1	Douglas			
Fidalgo Island Packing Co	2	Bay of Pillars	4		4
		Ketchikan	6	1	7
George Inlet Packing Co	1	George Inlet	1	2	3
P. E. Harris & Co	1	Hawk Inlet		6	6
Hetta Packing Co	1	Coppermount			
Hidden Inlet Canning Co	1	Hood Bay		3	3
Hoonah Packing Co	1	Gambier Bay	5		5
Karheen Packing Co	1	Karheen	6		6
Libby, McNeill & Libby	3	Ketchikan (floating)	3		3
		Taku Harbor	12		12
		Yakutat			
Mountain Point Packing Co	1	Wrangell Narrows	1	1	2
Geo. T. Myers & Co	1	Chatham	3		3
Nakat Packing Corporation	4	Heceta Island		8	8
		Hidden Inlet	1	9	10
		Union Bay		11	11
		Waterfall		6	6
New England Fish Co	2	Ketchikan			
		Noyes Island		3	3
Northland Packing Co	1	Ketchikan	2	2	4
North Pacific Trading & Packing Co	1	Klawak	1	4	5
Northwestern Fisheries Co	5	Boca de Quadra	4	3	7
		Dundas Bay		3	3
		Hunter Bay		3	3
		Kasaan	5	1	6
		Shakan	1	3	4
Pacific American Fisheries	1	Excursion Inlet	6	3	9
Petersburg Packing Co	1	Petersburg	5	6	11
Point Warde Fisheries	1	Point Warde		1	1
Pure Food Fish Co	1	Ketchikan	3		3
Pyramid Packing Co	1	Sitka		5	5
Red Salmon Packers Association	1	Dry Bay and Situk River (floating).			
Sanborn-Cutting Co	1	Kake		9	9
Sea-Coast Packing Co	1	Craig		6	6
Sebastian Stuart Fish Co	1	Tyee	1		1
J. L. Smiley & Co	1	Ketchikan	4	4	8
Starr-Collinson Packing Co	1	Moira Sound		2	2
Straits Packing Co	1	Skowl Arm			
Stuart Corporation, The	1	Ketchikan	1	2	3
Sunny Point Packing Co	1	----do	6	2	8
Superior Fisheries Co	1	Tenakee	4		4
Thlinket Packing Corporation	1	Funter Bay	1	7	8
Ward's Cove Packing Co	1	Ward Cove	1		1
Central Alaska:					
Alaska Packers Association	3	Alitak	2		2
		Chignik	4		4
		Karluk	2		2
Alaska Year-Round Canneries Co	1	Seldovia	3		3
Alitak Packing Co	1	Lazy Bay	4		4
Carlisle Packing Co	1	Cordova	4		4
Columbia River Packers Association	1	Chignik	3		3
Cook Inlet Packing Co	1	Seldovia*	4		4
Copper River Packing Co	1	McClure Bay	3	1	4
Emel Packing Co	1	Valdez	3		3
Fidalgo Island Packing Co	1	Port Graham	6		6
Gorman & Co	2	Anchorage	8		8
		Drier Bay		1	1
P. E. Harris & Co	1	Isanotski Strait	5		5
Hoonah Packing Co	1	Bering River			
International Packing Co	1	Kiliuda Bay (floating)			
Kadiak Fisheries Co	1	Kodiak	3		3
Katmai Packing Co	1	Uzinki			
W. A. Keller	1	Deep Creek *			
Kodiak Island Fishing & Packing Co	1	Uganik Bay			
Libby, McNeill & Libby	1	Kenai	14		14
Moore Packing Co	1	Orca Inlet	2		2
North Coast Packing Co	1	Ninilchik	3		3
Northern Light Packing Co	1	Mountain Slough			
Northwestern Fisheries Co	3	Chignik	3		3
		Kenai	6		6
		Uyak			
Orca Packing Co	1	Cordova			

Companies that can salmon in Alaska, number and location of canneries operated, and number of traps owned by each, 1925—Continued

Company	Canneries		Traps		
	Number	Location	Driven	Floating	Total
Central Alaska—Continued.					
Pacific American Fisheries	3	Ikatan	11		11
		King Cove	10		10
		Unakwik Inlet (leased)			
Pioneer Packing Co	1	Cordova		1	1
Pioneer Sea Foods Co	1	Eyak River		1	1
Robinson Packing Corporation	1	Zachar Bay			
San Juan Fishing & Packing Co	1	Evans Bay	9		9
Seashore Packing Co	1	Kukak Bay			
Shepard Point Packing Co	1	Shepard Point		2	2
Shumagin Packing Co	1	Squaw Harbor	4		4
Western Alaska:					
Alaska Packers Association	9	Egegik River			
		Kvichak Bay (2)			
		Naknek River (3)			
		Nushagak Bay (2)			
		Ugashik River			
Alaska-Portland Packers Association	2	Naknek River			
		Nushagak Bay			
Alaska Salmon Co	1	Wood River			
Bristol Bay Packing Co	1	Kvichak Bay			
Carlisle Packing Co	1	Kvichak River			
Columbia River Packers Association	1	Nushagak Bay			
Everett Packing Co	1	Herendeen Bay			
International Packing Co	1	Ugashik River and Makushin Bay (floating).			
Libby, McNeill & Libby	6	Egegik River			
		Ekuk			
		Koggiung			
		Libbyville			
		Lockanok			
		Nushagak			
Nakat Packing Corporation, The	1	Nakeen*			
Naknek Packing Co	1	Naknek River			
Northwestern Fisheries Co	2	do			
		Nushagak			
Pacific American Fisheries	1	Port Moller	4		4
Red Salmon Canning Co	2	Naknek River			
		Ugashik River			

LOSSES AND DISASTERS

The cannery of the F. C. Barnes Co. at Lake Bay burned early in April, but was rebuilt and ready for operation in June. The loss was $60,000. The Alaska Consolidated Canneries reported that the China house at their Chomly plant burned, which, with gear, amounted to a loss of $6,419 to the company. The gas boat *Wanderer* of the Beauclaire Packing Co., a tender belonging to the Northwestern Fisheries Co., and a vessel chartered by the Seacoast Packing Co., totaling $14,960 in value, were lost. Other losses of fishing gear, small boats, and buildings in southeastern Alaska amounted to $27,840. Ten lives were lost—4 shoresmen through disease, 2 drowned, and 1 killed accidentally; 1 fisherman and 1 transporter drowned, and 1 transporter accidentally killed.

In the central district, losses of fishing gear, small boats, and buildings totaling $20,940 were reported. One fisherman was drowned and two shoresmen died of disease.

In the western district the Pacific American Fisheries lost the gas boat *Virginius*, valued at $6,100; the Alaska-Portland Packers Association lost a launch valued at $2,231; and Libby, McNeill & Libby reported the loss of a pile driver valued at $5,250. The Bristol Bay

FIG. 8.—Hauling beach seine at Karluk

Packing Co. reported the loss of canned salmon valued at $20,640. Fishing gear, small boats, and equipment valued at $44,997 also were lost in the district. One fisherman was killed accidentally, one was drowned, and seven fishermen and nine shoresmen died of disease.

STATISTICS

In 1925, 129 canneries were operated in Alaska, 1 less than in 1924. The active investment in the industry was $53,543,544, a gain of $865,874, or 1.6 per cent, over 1924. The increase in southeast Alaska was $794,697, or 3 per cent; in central Alaska the investment declined $459,756, or nearly 4 per cent; and in western Alaska it increased $530,933, or slightly over 3 per cent.

Employment was given to 21,805 persons, as compared with 20,107 in 1924, an increase of 1,698, or 8.4 per cent. White employees increased 1,048, Japanese 144, Filipinos 550, Mexicans 183, negroes 77, Porto Ricans 21, and miscellaneous 18, while natives decreased 256 and Chinese 87.

The total pack of canned salmon was 4,459,937 cases, valued at $31,989,531. This was a decline from 1924 of 834,978 cases, or approximately 15.8 per cent, and a decrease in value of $1,017,604, or 3 per cent. The output in southeastern Alaska increased from 2,787,789 cases to 2,802,414, or slightly over one-half of 1 per cent; while in central Alaska it declined from 1,605,107 cases to 1,052,593, or nearly 35 per cent, and in western Alaska from 902,019 cases to 604,930, or nearly 33 per cent. The decline was attributable chiefly to the smaller runs of humpbacks in central Alaska and of reds in western Alaska. In Alaska as a whole the pack of chums increased from 1,028,488 to 1,078,680 cases, or 4.9 per cent; and that of kings from 33,648 to 49,978 cases, or 48.5 per cent. The coho pack decreased from 183,601 to 161,010 cases, or about 12 per cent; humpbacks from 2,601,283 to 2,110,593 cases, or 18.8 per cent; and reds from 1,447,895 to 1,059,676 cases, or about 26 per cent.

Persons engaged in the Alaska salmon-canning industry in 1925

Occupation and race	Southeast Alaska	Central Alaska	Western Alaska	Total
Fishermen:				
Whites	1,194	929	2,605	4,728
Natives	1,276	327	122	1,725
Filipinos	11			11
Mexicans	1			1
Miscellaneous [1]	6			6
Total	2,488	1,256	2,727	6,471
Shoresmen:				
Whites	2,331	895	2,061	5,287
Natives	1,279	565	143	1,987
Chinese	436	247	559	1,242
Japanese	842	424	252	1,518
Filipinos	1,265	442	506	2,213
Mexicans	139	82	1,281	1,502
Negroes	1	24	227	252
Porto Ricans	11	3	136	150
Miscellaneous [1]	38		50	88
Total	6,342	2,682	5,215	14,239

[1] Hawaiians, Koreans, Kanakas, etc.

Persons engaged in the Alaska salmon-canning industry in 1925—Continued

Occupation and race	Southeast Alaska	Central Alaska	Western Alaska	Total
Transporters:				
Whites	653	239	131	1,023
Natives	23	23		46
Chinese	1		5	6
Japanese	8	3	1	12
Filipinos	5	1		6
Mexicans	1			1
Miscellaneous [1]	1			1
Total	692	266	137	1,095
Total:				
Whites	4,178	2,063	4,797	11,038
Natives	2,578	915	265	3,758
Chinese	437	247	564	1,248
Japanese	850	427	253	1,530
Filipinos	1,281	443	506	2,230
Mexicans	141	82	1,281	1,504
Negroes	1	24	227	252
Porto Ricans	11	3	136	150
Miscellaneous [1]	45		50	95
Grand total	9,522	4,204	8,079	21,805

[1] Hawaiians, Koreans, Kanakas, etc.

Investment in the Alaska salmon-canning industry in 1925

Items	Southeast Alaska		Central Alaska		Western Alaska		Total	
	Number	*Value*	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*
Plants operated	62	$6,734,690	37	$3,590,837	30	$5,768,253	129	$16,093,780
Operating capital		8,788,501		3,732,222		3,041,987		15,562,710
Wages paid		3,882,244		2,191,199		3,131,492		9,204,935
Vessels:								
Power, over 5 tons	377	2,465,758	96	971,169	96	1,949,528	569	5,386,455
Net tonnage	7,179		2,647		24,188		34,014	
Sailing	2	85,000	4	191,000	13	601,000	19	877,000
Net tonnage	3,843		7,221		23,275		34,339	
Barges	7	28,700	2	6,000			9	34,700
Net tonnage	2,531		30				2,561	
Launches	120	152,343	76	79,732	39	87,711	235	319,786
Seine boats	225	95,573	94	23,240	5	375	324	119,188
Gill net boats	87	15,747	135	91,990	1,252	509,522	1,474	617,259
Rowboats and skiffs	803	40,406	565	30,710	139	10,540	1,507	81,656
Lighters and scows	367	394,995	180	146,442	170	377,746	717	919,183
Houseboats	35	33,044	4	3,515	21	51,320	60	87,879
Pile drivers	64	441,689	33	181,235	23	59,965	120	682,889
Pile pullers	6	39,890					6	39,890
Apparatus:								
Beach seines	9	1,103	82	40,120			91	41,223
Fathoms	950		11,490				12,440	
Purse seines	374	285,633	37	18,400	10	13,750	421	317,783
Fathoms	64,117		5,340		2,500		71,957	
Gill nets	190	23,784	753	59,455	2,049	353,827	2,992	437,066
Fathoms	20,871		44,814		264,600		330,285	
Traps, driven	158	1,173,878	126	548,222	4	20,000	288	1,742,100
Traps, floating	248	942,662	8	35,400			256	978,062
Total		25,625,640		11,940,888		15,977,016		53,543,544

Output and value of canned salmon in Alaska in 1925 [1]

Product	Southeast Alaska		Central Alaska		Western Alaska		Total	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*	*Cases*	*Value*
Coho, or silver:								
½-pound flat	5,800	$89,810	1,330	$14,906	15	$240	7,145	$104,956
1-pound flat	3,960	44,472	3,263	27,714			7,223	72,186
1-pound tall	81,592	778,462	63,696	596,254	1,354	13,901	146,642	1,388,617
Total	91,352	912,744	68,289	638,874	1,369	14,141	161,010	1,565,759
Chum, or keta:								
½-pound flat	2,905	20,133	146	876			3,051	21,009
1-pound tall	845,008	3,705,085	200,128	923,290	30,493	137,646	1,075,629	4,766,021
Total	847,913	3,725,218	200,274	924,166	30,493	137,646	1,078,680	4,787,030
Humpback, or pink:								
½-pound flat	27,170	213,360	6,835	46,192			34,005	259,552
1-pound flat	185	928					185	928
1-pound tall	1,680,101	8,850,421	396,157	2,025,523	145	678	2,076,403	10,876,622
Total	1,707,456	9,064,709	402,992	2,071,715	145	678	2,110,593	11,137,102
King, or spring:								
½-pound flat	748	12,704	2,007	28,949			2,755	41,653
1-pound flat	4,663	63,734	3,965	48,354	200	1,500	8,828	113,588
1-pound tall	6,594	69,841	13,328	152,107	18,473	217,852	38,395	439,800
Total	12,005	146,279	19,300	229,410	18,673	219,352	49,978	595,041
Red, or sockeye:								
½-pound flat	28,947	463,309	25,175	430,618	14,779	250,568	68,901	1,144,495
1-pound flat	6,242	85,289	20,195	264,986	2,320	29,607	28,757	379,882
1-pound tall	108,499	1,353,656	316,368	4,107,698	537,151	6,918,868	962,018	12,380,222
Total	143,688	1,902,254	361,738	4,803,302	554,250	7,199,043	1,059,676	13,904,599
Grand total	2,802,414	15,751,204	1,052,593	8,667,467	604,930	7,570,860	4,459,937	31,989,531

[1] Cases containing ½-pound cans have been reduced one-half in number, and thus, for the purpose of affording fair comparison, all are put upon the basis of forty-eight 1-pound cans to the case.

Output of canned salmon in Alaska, in cases, 1920 to 1925 [1]

Product	1920	1921	1922	1923	1924	Average for 5-year period, 1920–1924	1925	Percentage of increase or decrease in 1925, as compared with 5-year average
Coho, or silver:								
½-pound flat	8,915	4,084	22,237	13,866	8,059	11,432	7,145	−37.50
1-pound flat	10,746	7,918	12,099	10,151	5,403	9,263	7,223	−22.02
1-pound tall	172,424	94,553	141,657	140,090	170,139	143,773	146,642	+01.99
Total	192,085	106,555	175,993	164,107	183,601	164,468	161,010	−02.10
Chum, or keta:								
½-pound flat	53	608	3,698	6,356	346	2,212	3,051	+37.93
1-pound flat	46,167		6,185	16	630	10,600		−100.00
1-pound tall	987,297	254,887	556.035	519,250	1,027,512	668,996	1,075,629	+60.78
Total	1,033,517	255,495	565,918	525,622	1,028,488	681,808	1,078,680	+58.21
Humpback, or pink:								
½-pound flat	18,970	1,292	42,736	29,363	21,365	22,745	34,005	+49.51
1-pound flat	76,017		30,879	9,428	13,095	25,884	185	−98.59
1-pound tall	1,498,133	422,692	1,584,808	2,409,338	2,566,823	1,696,359	2,076,403	+22.40
Total	1,593,120	423,984	1,658,423	2,448,129	2,601,283	1,744,988	2,110,593	+20.95
King, or spring:								
½-pound flat	10,196	4,061	3,770	5,466	1,501	4,999	2,755	−44.89
1-pound flat	18,319	19,192	3,967	7,281	9,500	11,652	8,828	−24.24
1-pound tall	81,488	21,741	22,923	25,596	22,647	34,879	38,395	+10.08
Total	110,003	44,994	30,660	38,343	33,648	51,530	49,978	−03.01
Red, or sockeye:								
½-pound flat	101,716	60,831	171,896	121,775	31,947	97,633	68,901	−29.43
1-pound flat	120,147	71,108	121,449	159,271	110,352	116,465	28,757	−75.31
1-pound tall	1,278,875	1,633,859	1,777,313	1,578,450	1,305,596	1,514,819	962,018	−36.49
Total	1,500,738	1,765,798	2,070,658	1,859,496	1,447,895	1,728,917	1,059,676	−38.71
Grand total	4,429,463	2,596,826	4,501,652	5,035,697	5,294,915	4,371,711	4,459,937	+02.02

[1] The number of cases shown has been put upon the common basis of forty-eight 1-pound cans per case.

Relative importance of each species of salmon canned within each district in 1925

District	Coho	Chum	Humpback	King	Red	Total, all species
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Southeast Alaska	3.3	30.3	60.9	0.4	5.1	100
Central Alaska	6.5	19.0	38.3	1.8	34.4	100
Western Alaska	.2	5.1	.0	3.1	91.6	100
All Alaska	3.6	24.2	47.3	1.1	23.8	100

Relative importance of each district in the production of each species of salmon canned in 1925

District	Coho	Chum	Humpback	King	Red	Total, all species
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Southeast Alaska	56.7	78.6	80.9	24.0	13.6	62.8
Central Alaska	42.4	18.6	19.1	38.6	34.1	23.6
Western Alaska	.9	2.8	.0	37.4	52.3	13.6
Total	100.0	100.0	100.0	100.0	100.0	100.0

Average annual price per case of forty-eight 1-pound cans of salmon, 1915 to 1925

Product	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925
Coho, or silver	$4.31	$5.34	$8.76	$9.15	$11.27	$9.13	$5.63	$5.47	$5.74	$6.83	$9.72
Chum, or keta	2.59	3.34	6.14	6.27	6.82	4.19	3.68	3.98	4.65	4.68	4.44
Humpback, or pink	2.78	3.64	6.44	6.58	8.35	5.47	4.21	4.34	4.86	4.93	5.28
King, or spring	4.63	5.36	10.40	9.85	13.13	10.97	10.22	8.08	8.56	8.89	11.91
Red, or sockeye	5.82	6.04	9.48	9.44	12.98	13.05	8.96	9.24	9.27	9.53	13.12

PACK IN CERTAIN DISTRICTS

Statistics of the salmon pack are again presented for subdivisions of the three main districts of Alaska, and comparison is made with similar statistics for 1924. These districts are described as follows:

Bristol Bay.—The Bering Sea shore east and north of the Ugashik River.

Port Moller and Herendeen Bay.—Port Moller, Herendeen Bay, and Nelson Lagoon.

Ikatan-Shumagin Islands.—False Pass, Ikatan Bay, King Cove, and the Shumagin Islands.

Chignik.—Three canneries located at Chignik.

Kodiak-Afognak Islands.—Kodiak, Spruce, and Raspberry Islands.

Cook Inlet.—The shores of Cook Inlet.

Prince William Sound.—Extends from Resurrection Bay to Point Whitshed, except that the pack of fish taken in the Copper River district by canneries at and near Cordova is omitted.

Copper and Bering Rivers.—Extends from Point Whitshed to Bering River and includes the pack by canneries at Cordova from fish not credited to Prince William Sound.

Yakutat and Dry Bay.—Extends from Yakutat Bay to and including Dry Bay.

Icy Strait-Lynn Canal.—West coast of Baranof and Chichagof Islands, the shores of Cross Sound, Icy Strait, Lynn Canal, and Stephens Passage south to Taku Harbor. Only part of the pack at

Taku Harbor is credited to this district, as some of it originated elsewhere.

Chatham Strait-Frederick Sound.—Includes part of the Taku cannery pack and the Petersburg Packing Co.'s pack, in addition to the packs of all canneries on both shores of Chatham Strait and its bays from Point Augusta to Cape Ommaney, and through Frederick Sound and its bays northward to Taku Harbor, including Kake.

Sumner Strait-Dixon Entrance.—Extends southward from Petersburg and eastward from Port Beauclerc to Cape Chacon and Dixon Entrance, and includes all canneries on the mainland and intervening islands from the Stikine River to Portland Canal.

West coast, Prince of Wales Island.—Territory west and south of a line from Cape Chacon to Point Baker and Cape Ommaney.

Pack of canned salmon in Alaska in 1925, by districts [1]

District	Coho	Chum	Humpback	King	Red	Total	Percentage of increase or decrease from 1924
	Cases	*Cases*	*Cases*	*Cases*	*Cases*	*Cases*	
Bristol Bay	1,369	25,597		17,016	524,395	568,377	−30.50
Port Moller and Herendeen Bay		4,896		1,657	28,669	35,232	−38.20
Ikatan-Shumagin Islands	12,283	102,579	18,573	2,578	60,756	196,769	−53.78
Chignik	2,915	8,374	2,727	299	65,203	79,518	−47.78
Kodiak-Afognak Islands	9,219	19,935	147,476	303	125,990	302,923	−18.47
Cook Inlet	11,886	1,654	449	10,629	86,211	110,829	−10.69
Prince William Sound	9,466	67,732	233,899	287	8,113	319,497	−27.78
Copper and Bering Rivers	22,520		13	5,204	16,651	44,388	−61.80
Yakutat and Dry Bay	13,768		5,856	4,663	10,899	35,186	−44.25
Icy Strait-Lynn Canal	17,014	132,192	125,189	687	58,923	334,005	−24.79
Chatham Strait-Frederick Sound	16,869	224,319	193,141	1,327	15,774	451,430	−20.34
Sumner Strait-Dixon Entrance	34,143	358,236	1,101,845	4,648	50,917	1,549,789	+12.31
West coast, Prince of Wales Island	9,558	133,166	281,425	680	7,175	432,004	+28.52
Total	161,010	1,078,680	2,110,593	49,978	1,059,676	4,459,937	−15.77

[1] Pack reduced to the basis of forty-eight 1-pound cans per case.

MILD CURING

In 1925 the salmon mild-cure industry of Alaska was maintained at about the level of production of the previous year, although the number of persons employed and the investment decreased, chiefly in consequence of the withdrawal of operators in the western district. There was an increase in the amount of product prepared in both the southeastern and central districts. The industry gave employment to 1,535 persons (1,319 whites, 215 natives, and 1 Filipino), which was 231 less than the number employed in 1924. The investment of $1,498,425, which was almost wholly in the southeastern district, was $80,810 less than in 1924.

The total output of mild-cured salmon in 1925 was 5,217,600 pounds, valued at $1,085,466, as against 5,187,200 pounds, valued at $1,137,301, in 1924, an increase of 30,400 pounds in quantity but a decrease in value of $51,835. The pack consisted of 279,200 pounds of cohos and 4,938,400 pounds of kings, all of which was produced in southeastern Alaska except 172,000 pounds of kings, which were produced in the central district. In units of 800-pound tierces, the pack consisted of 349 tierces of cohos and 6,173 tierces of kings.

Persons engaged, investment, and products of Alaska salmon mild-curing industry in 1925

Items	Southeast Alaska		Central Alaska		Total	
PERSONS ENGAGED						
Fishermen:	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*
Whites	1,200		18		1,218	
Natives	185		10		195	
Total	1,385		28		1,413	
Shoresmen:						
Whites	60		11		71	
Natives	11		7		18	
Total	71		18		89	
Transporters:						
Whites	22		8		30	
Natives			2		2	
Filipinos			1		1	
Total	22		11		33	
Grand total	1,478		57		1,535	
INVESTMENT						
Plants operated	12	$47,259	2	$23,727	14	$70,986
Operating capital		443,408		45,406		488,814
Vessels:						
Power, over 5 tons	21	125,365	1	4,000	22	129,365
Net tonnage	403		14		417	
Barges	2	6,400			2	6,400
Net tonnage	184				184	
Launches	726	727,500	6	14,600	732	742,100
Gill-net boats			15	1,750	15	1,750
Rowboats	206	7,120	4	100	210	7,220
Lighters and scows	2	290	9	11,000	11	11,290
Apparatus:						
Gill nets (2,500 fathoms)			100	5,500	100	5,500
Traps (driven)			2	3,000	2	3,000
Lines	3,200	32,000			3,200	32,000
Total		1,389,342		109,083		1,498,425
PRODUCTS (POUNDS)						
Coho, or silver	279,200	37,630			[1] 279,200	37,630
King, or spring	[2] 4,766,400	1,014,858	[3] 172,000	32,978	[4] 4,938,400	1,047,836
Total	5,045,600	1,052,488	172,000	32,978	5,217,600	1,085,466

[1] 349 tierces. [2] 5,958 tierces. [3] 215 tierces. [4] 6,173 tierces.

PICKLING

The pickled-salmon industry, which is carried on chiefly in western Alaska, has been declining gradually in recent years. With the depletion of the red-salmon runs, particularly in Bristol Bay, the packers have been increasingly anxious to utilize more of the catch of this species for canning. The largest saltery in the Bristol Bay district, formerly operated by Peter M. Nelson, was sold this year to the Nakat Packing Corporation and converted into a cannery. One new concern, the Westward Packing Co., which operated a floating saltery, entered this district in 1925; but as a result of the small run it made a light pack and later sold its plant.

The investment of $203,000 in the salmon-pickling industry was divided—$156,469 in western and $46,531 in central Alaska. There were slight increases in the number of persons engaged and the total investment but a considerable decrease in amount and value of products. In southeastern Alaska production increased from 40,700

pounds in 1924 to 94,900 pounds in 1925; while in central Alaska it decreased from 296,952 pounds to 229,200 pounds, and in western Alaska from 1,025,300 pounds to 305,500 pounds. The total output in 1925 was 629,600 pounds, valued at $84,731, as compared with 1,362,952 pounds in 1924, valued at $132,223, a shrinkage of 54 per cent in quantity and 36 per cent in value.

Persons engaged, investment, and products of Alaska salmon-pickling industry in 1925

Items	Southeast Alaska		Central Alaska		Western Alaska		Total	
PERSONS ENGAGED								
Fishermen:	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*
Whites			9		44		53	
Natives			15		8		23	
Total			24		52		76	
Shoresmen:								
Whites					34		34	
Natives			5		4		9	
Total			5		38		43	
Transporters:								
Whites					3		3	
Grand total			29		93		122	
INVESTMENT								
Plants operated			4	$23,800	5	$48,825	9	$72,625
Operating capital				8,736		60,594		69,330
Vessels:								
Power, over 5 tons			1	3,000			1	3,000
Net tonnage			8				8	
Sailing					1	18,000	1	18,000
Net tonnage					570		570	
Launches			5	3,500	7	8,550	12	12,050
Seine boats			4	540			4	540
Gill-net boats			1	75	20	10,510	21	10,585
Rowboats			9	650	10	800	19	1,450
Lighters and scows			1	600	2	3,000	3	3,600
Apparatus:								
Beach seines			5	4,950			5	4,950
Fathoms			645				645	
Purse seines			1	500			1	500
Fathoms			100				100	
Gill nets			2	180	53	5,540	55	5,720
Fathoms			170		4,750		4,920	
Wheels					5	650	5	650
Total				46,531		156,469		203,000
PRODUCTS (POUNDS)								
Coho, or silver	80,500	$7,853	87,250	9,636	5,600	630	173,350	18,119
Chum, or keta	4,200	420	9,400	1,025	12,300	1,100	25,900	2,545
Humpback, or pink	8,200	686	30,250	3,255			38,450	3,941
King, or spring	1,800	144	500	62	121,000	18,046	123,300	18,252
Red, or sockeye	200	27	101,800	10,787	166,600	31,060	268,600	41,874
Total	94,900	9,130	229,200	24,765	305,500	50,836	629,600	84,731

FRESH SALMON

The fresh-salmon business of Alaska represents no appreciable independent investment, being largely incidental to the mild curing of salmon and freezing of halibut. There were two dealers in southeastern Alaska, whose chief product was fresh salmon. The cost of operations was $10,861, and five white shoresmen were reported employed. The total production was 2,620,017 pounds of all species,

valued at $223,907, all in southeastern Alaska. This was an increase of 413,073 pounds in quantity and $20,283 in value, or approximately 18 per cent in quantity and 10 per cent in value over 1924.

Products of the Alaska fresh-salmon industry in 1925

Species	Pounds	Value
Coho, or silver	615,537	$33,055
Chum, or keta	27,369	840
Humpback, or pink	3,064	46
King, or spring	1,943,988	186,124
Red, or sockeye	30,059	3,842
Total	2,620,017	223,907

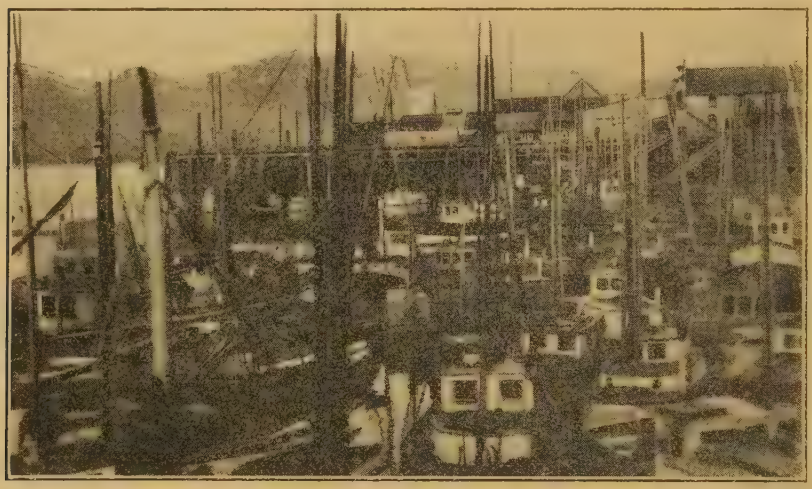

FIG. 9.—Fleet of small fishing boats at Ketchikan

FREEZING

No independent investment was credited to the salmon-freezing business in Alaska in 1925, the operations being wholly incidental to other lines of the fishery industry. There was an increase in production of 284,957 pounds, or 12 per cent, over 1924, the total output in 1925 being 2,572,623 pounds, valued at $170,663, as compared with 2,287,666 pounds, valued at $165,809 in 1924.

Products of the Alaska frozen-salmon industry in 1925

Species	Pounds	Value
Coho, or silver	686,045	$37,118
Chum, or keta	423,619	12,550
King, or spring	1,462,959	120,995
Total	2,572,623	170,663

DRY-SALTING, DRYING, AND SMOKING

In southeastern Alaska, one operator prepared 5,200 pounds of dry-salted cohos, valued at $582; and in central Alaska there were prepared 16,700 pounds of dried and smoked salmon, valued at $958, and 1,400 pounds of beleke, valued at $380. All of these operations were incidental to other lines of business. In the fishery of the Yukon, Tanana, and Kuskokwim Rivers, which is carried on principally by natives, 1,024,745 pounds of salmon were dried and smoked, valued at $124,545. In this western district 51 whites and 362 natives were engaged in the fishery and the apparatus used consisted of 220 wheels, valued at $22,000, and 235 gill nets of 3,196 fathoms, valued at $3,196, a total investment of $25,196.

Production of dry-salted, dried, and smoked salmon in Alaska in 1925

Product	Southeast Alaska		Central Alaska		Western Alaska		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Dry-salted:								
Coho or silver	5,200	$582					5,200	$582
Dried and smoked:								
Coho, or silver			9,900	$506			9,900	506
Chum, or keta			925	44	636,545	$76,385	637,470	76,429
Humpback, or pink			3,445	255			3,445	255
King, or spring					125,200	16,600	125,200	16,600
Red, or sockeye			2,430	153	263,000	31,560	265,430	31,713
Total			16,700	958	1,024,745	124,545	1,041,445	125,503
Beleke:								
Coho, or silver			200	80			200	80
Humpback, or pink			1,200	300			1,200	300
Total			1,400	380			1,400	380
Grand total	5,200	582	18,100	1,338	1,024,745	124,545	1,048,045	126,465

BY-PRODUCTS

Two companies in southeastern Alaska engaged primarily in the preparation of salmon by-products, while three salmon canneries in central Alaska manufactured salmon oil and fertilizer as well. The investment, which was credited wholly to southeastern Alaska, totaled $120,981, and 35 white shoresmen and 5 white transporters were reported engaged in the industry. The total production was 1,432,625 pounds of fertilizer, valued at $41,807, and 40,680 gallons of oil, valued at $18,330. This was a decrease of 326,675 pounds, or 19 per cent, in quantity and $1,563 in value of fertilizer, and 8,353 gallons, or 17 per cent, in quantity, and $3,503 in value of oil from 1924. In that year 3 companies in southeastern Alaska engaged primarily in by-products manufacture, in addition to which 3 plants in southeastern and 2 in central Alaska manufactured fertilizer and oil in connection with their salmon-canning operations.

Production of salmon oil and fertilizer in Alaska in 1925

Districts	Oil		Fertilizer	
	Gallons	*Value*	*Pounds*	*Value*
Southeast Alaska	26,500	$11,950	1,074,000	$31,990
Central Alaska	14,180	6,380	358,625	9,817
Total	40,680	18,330	1,432,625	41,807

HERRING

The greatest expansion of Alaska fishery operations in 1925 occurred in the herring industry. This increase was due chiefly to the larger output of fertilizer and oil in southeastern Alaska and the development of the herring fishery around Afognak Island, at which place there was a marked influx of operators.

An interesting development in the herring fishery of Alaska was the use of large vessels as floating plants that were transferred from one district to another to take advantage of the seasonal runs. The most important operators of this type were: Atlantic & Pacific Packing Co., with the *ZR3* (1,600 tons); North American Fisheries, with the *Rosamond* (1,035 tons); Ottar Hofstad, with the *Esther* (222 tons); Utopian Fisheries, with the *Donna Lane* (1,597 tons); and Libby, McNeill & Libby, with the *Salvator* (385 tons). The Alaska Con-

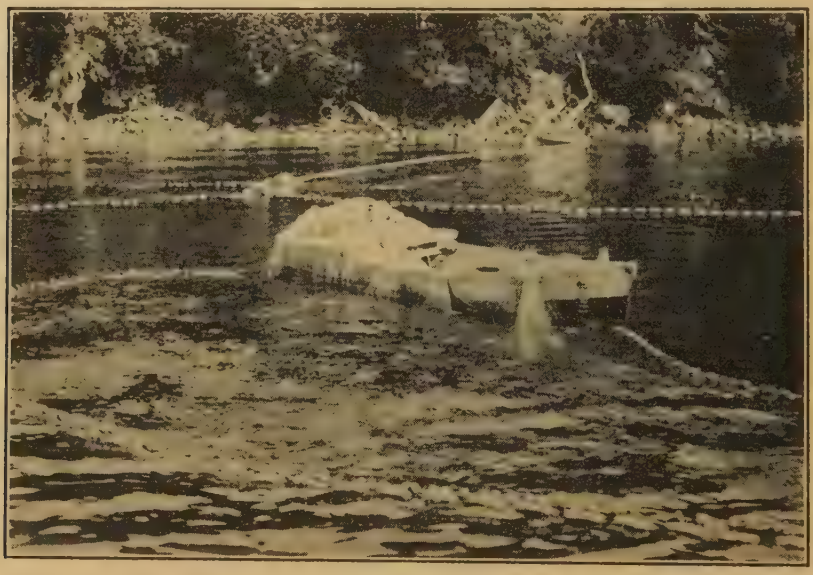

FIG. 10.—Herring pounds at Red Fox Bay, Afognak Island

solidated Fisheries chartered the motorship *La Merced* (1,247 tons net) to transport supplies to its plant at Portlock City, and it was also used as a saltery at that place while the plant was being rebuilt. The Latouche Packing Co. outfitted the *Wakina* (216 tons) at Seattle as a floating saltery, but the vessel burned while en route to Alaska, resulting in a loss of about $14,000. A number of small floating plants were operated in various districts.

George A. Rounsefell was employed in 1925 as a scientific assistant to undertake a biological investigation of the herring of Alaska. He made a preliminary survey, visited all of the more important herring centers, and collected considerable information. The investigation will be continued in 1926.

During the season of 1925 there was considerable adverse criticism in southeastern Alaska in regard to the use of excessive quantities of herring for the manufacture of fertilizer and oil. It was asserted

that greater quantities of herring were taken by seines than could be transported to the plants, and that consequently they were then dumped and wasted. The entire matter was investigated by the bureau, in collaboration with the Department of Justice. The following is an extract from the report of the grand jury at its special November, 1925, term at Juneau:

The attention of this grand jury was called to a letter written on August 1, 1925, by Mr. C. B. Ferguson, of Craig, Alaska, to the Governor of Alaska, alleging that there was gross criminal and wanton waste of herring fish in the vicinity of Port Walter, Alaska, during the past season. Mr. Ferguson's letter was published in the "Alaska Fisherman" and other newspapers. The grand jury subpœnaed Mr. Ferguson to appear before it and examined him as a witness in this matter. Mr. Ferguson stated that he was in Port Walter and Chatham Straits shortly before he wrote to the governor, but he had no first-hand information, and that his allegations to the governor were based upon statements made

FIG. 11.—Herring purse-seine boats at Seldovia

to him by one Ed. Donnelly. It appears that Donnelly had been employed as a cook in a reduction plant at Port Walter, but left there late in August for Seattle, Wash., and has not been located.

We also examined officers of the Bureau of Fisheries and of the Department of Justice who had made extensive investigations of the matters complained of by Mr. Ferguson. These officers had been unable to find any evidence substantiating the charges made by Mr. Ferguson. This grand jury also examined salmon trollers living in the country where the waste was alleged to have taken place, but found no evidence that such waste had in fact occurred.

Mr. Ferguson stated to the grand jury that the manufacture of herring into oil and fertilizer is, of itself, a waste of food fish which should be stopped by the United States Bureau of Fisheries. We find no law under which the Secretary of Commerce, the Commissioner of Fisheries, or other officers of the Government, could curtail this industry by regulation. We believe, however, that the Secretary of Commerce should be vested by Congress with power to abate the manufacture of food fish into fertilizer, oil, or other by-products, whenever or wherever such action appears necessary to insure against depleting the supply of herring or other fish for food purposes, or the use of herring for bait.

Consideration has been given to the important matter of determining what proportion of the herring catch is used for food products and what is converted into oil and fertilizer. According to available figures, two-thirds of the total catch were used for fertilizer and oil and one-third was prepared for food or used as halibut bait. In southeastern Alaska where the herring average considerably smaller in size than those in central and western Alaska, most of the fish are used for other than food purposes. The manufacture of herring fertilizer and oil centered in the southeastern district, where more than 88 per cent of the catch was utilized in this way. In central Alaska only about one-fifth of the catch was used in the manufacture of fertilizer and oil, as the business was confined to Prince William Sound. To arrive at the foregoing figures it was estimated that about 1 ton of fertilizer and 300 gallons of oil can be produced from 6 tons of raw herring. Of the 18 concerns that manufactured oil and fertilizer, only five were exclusively reduction plants, the others being engaged in the preparation of food products also.

In the southeastern district, the Alaska Herring & Sardine Co., at Little Port Walter, canned salmon and prepared Scotch-cured herring, oil, and fertilizer. Fifteen other concerns prepared herring products principally, among which were the following:

Salteries:	
Douglas Fish Co	Todd.
National Fish Co	Killisnoo and Hood Bay.
Reduction plants:	
Hamilton Packing Co	Hood Bay.
Killisnoo Fisheries	Killisnoo.
Marine Packing & Reduction Co	Washington Bay.
Puget Sound Reduction Co	Port Armstrong.
Saltery and reduction plants:	
Alaska Consolidated Canneries	Saginaw Bay.
Arentsen & Co	Big Port Walter.
Baranof Packing Co	Red Bluff Bay.
Buchan & Heinen	Port Armstrong.
Chatham Strait Fish Co	New Port Walter.
Ness Fish Co	Petersburg.
Northwestern Herring Co	Port Conclusion.

In addition, five cold-storage plants froze herring for bait for the halibut fishery, and a number of fishermen were engaged in catching herring solely for bait.

In central Alaska, operations were conducted in three localities—Prince William Sound, with 12 operators; Cook Inlet, with 29 operators; and Kodiak-Afognak district, with 15 operators. In the Prince William Sound district the following companies operated:

Reduction plant:	
Alaska By-Products Co	Port Benny.
Salteries:	
Atlantic & Pacific Packing Co	Floating plant.
J. J. Hovd	Horseshoe Bay.
Johnson Packing Co	Latouche.
Latouche Packing Co	Port Crawford.
Utopian Fisheries	Floating plant.
Saltery and reduction plants:	
Everett-Pacific Fisheries	Thumb Bay.
Franklin Packing Co	Port Ashton.
W. J. Imlach Packing Co	Port Benny.
Knight Island Packing Co	Drier Bay.
San Juan Fishing & Packing Co	Evans Bay.
S. Sklaroff & Sons	Crab Bay.

In the Cook Inlet district no reduction plants were operated; the following were among the larger concerns salting herring for food:

Alaska Consolidated Fisheries	Portlock City.
R. V. Anderson	Seldovia.
Herring Bay Packing Co	Do.
W. J. Imlach Packing Co	Do.
Johnson & Sunsby	Do.
S. Sklaroff & Sons	Homer Spit.
Atlantic & Pacific Packing Co	Floating plant.
Fidalgo Island Packing Co	Port Graham.
Ottar Hofstad	Floating plant.
Ed. Jacobsen & Co	Seldovia.
Conrad Johnson	Halibut Cove.
Knight Island Packing Co	Do.
Lippincott & Eide	Do.
Meredith Gissberg & Larein	Do.
Axel Norstedt	Seldovia.
North Coast Packing Co	Halibut Cove.
E. Sivertson	Do.
Libby, McNeill & Libby	Floating plant.
North American Fisheries	Do.
San Juan Fishing & Packing Co	Tutka Bay.

The chief operators in the Kodiak-Afognak district operating salteries only were:

Atlantic & Pacific Packing Co	Floating plant.
Caw Packing Co	Uzinki.
W. J. Imlach Packing Co	Do.
Franklin Packing Co	Floating plant.
Ottar Hofstad	Do.
Johnson Packing Co	Do.
Kodiak Herring Co	Do.
North American Fisheries	Do.
San Juan Fishing & Packing Co	Uganik Bay.
Shuyak Packing Co	Shuyak Island.
Svendsen & Shaw Packing Co	Do.
Utopian Fisheries	Floating plant.

It was estimated that about 51,000 barrels of herring from the waters of Afognak Reserve and about 40,000 barrels from Cook Inlet were salted.

STATISTICAL SUMMARY

The herring industry in Alaska employed 1,839 persons in 1925, as compared with 1,407 in 1924. The number of plants increased from 32 in 1924 to 54 in 1925, and the investment from $3,849,422 to $6,108,494, or 58.7 per cent. The products were valued at $3,852,449, as compared with $2,458,370 in 1924, an increase of $1,394,079, or 56.7 per cent. Scotch-cured herring increased from 19,020,650 pounds in 1924 to 33,925,975 pounds in 1925, or approximately 78.3 per cent. Herring for bait increased from 3,599,350 pounds to 7,086,840 pounds. Fertilizer increased 83.5 per cent in quantity and 120 per cent in value, and oil 105.4 per cent in quantity and 98 per cent in value over the production in 1924.

Persons engaged, investment, and products of Alaska herring industry in 1925

Items	Southeast Alaska		Central Alaska		Western Alaska		Total	
PERSONS ENGAGED								
Fishermen:	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*
Whites	210		331				541	
Natives	14		6		6		26	
Total	224		337		6		567	
Shoresmen:								
Whites	434		658				1,092	
Natives	13		57		10		80	
Chinese	2				17		19	
Japanese	2						2	
Total	451		715		27		1,193	
Transporters:								
Whites	10		66				76	
Natives	2						2	
Negro	1						1	
Total	13		66				79	
Grand total	688		1,118		33		1,839	
INVESTMENT								
Plants operated	13	$936,682	40	$755,820	1	$12,885	54	$1,705,387
Operating capital		1,399,759		1,810,651		2,685		3,213,095
Vessels:								
Power, over 5 tons	35	288,573	70	588,600			105	877,173
Net tonnage	909		6,222				7,131	
Sailing			1	30,000			1	30,000
Net tonnage			1,035				1,035	
Barges	1	1,000	1	9,800			2	10,800
Net tonnage	250		385				635	
Launches, under 5 tons	5	4,100	19	17,300	2	1,800	26	23,200
Seine boats	9	11,697	13	13,405			22	25,102
Gill-net boats	5	175	4	400	8	400	17	975
Rowboats	15	465	41	1,795			56	2,260
Lighters and scows	7	8,177	14	12,200			21	20,377
Pile drivers			2	6,000			2	6,000
Apparatus:								
Purse seines	36	75,732	43	86,094			79	161,826
Fathoms	6,281		6,800				13,081	
Gill nets			73	6,379	30	720	103	7,099
Fathoms			2,740		540		3,280	
Impounding nets			18	25,200			18	25,200
Fathoms			2,140				2,140	
Total		2,726,360		3,363,644		18,490		6,108,494
PRODUCTS (POUNDS)								
Fresh, for bait	2,821,750	17,661	30,000	450			2,851,750	18,111
Frozen, for bait	4,235,090	21,315					4,235,090	21,315
Pickled for food:								
Scotch cure	4,641,625	307,063	29,243,190	1,960,514	41,160	3,000	33,925,975	2,270,577
Norwegian	232,000	14,770	133,225	8,199			365,225	22,969
Spiced	10,200	1,200					10,200	1,200
Bloaters			190,575	7,660			190,575	7,660
Dry-salted	273,000	3,660	404,705	16,314			677,705	19,974
Canned (38 cases)			1,824	150			1,824	150
Fertilizer	15,176,646	438,468	1,995,381	52,980			17,172,027	491,448
Oil, gallons	2,061,398	870,589	289,754	128,456			2,351,152	999,045
Total		1,674,726		2,174,723		3,000		3,852,449

HALIBUT

The closed season designated in the North Pacific halibut treaty, and which extends from November 16 to February 15, became effective for the first time in the fall of 1924; hence 1925 was the first year in which there was no halibut fishing for three full months. The shortness of the fishing season in 1925 probably was responsible in part for the small catch. The market was rather dull at the beginning of the season because there were on hand large quantities of halibut from the preceding year. Prices improved later, but the total catch was considerably less than that of 1924.

Halibut taken in the vicinity of Kodiak Island and the Sanak and Shumagin Islands were landed at Seattle in 1925. The trips to these islands were in the nature of prospecting expeditions, as the distance involved may preclude profitable operations except by vessels capable of cruising far and having large capacity. In time, however, these western banks undoubtedly will be fished more and more.

In 1925 L. T. Hopkinson, fishery expert of the Tariff Commission, conducted an economic survey of the halibut industry of the Pacific coast and Alaska. Hearings were held at Seattle on August 10 and 11 to consider the possibility of reducing the import duty on halibut, but the findings of the commission had not been made public by the end of 1925.

A matter of great importance to the halibut industry is the comprehensive investigation begun by the International Fisheries Commission under the direction of William F. Thompson, who for years has been identified with studies of the Pacific halibut question for the United States and Canada. Work began in June with the tagging of halibut in Dixon Entrance, and later was extended to other banks. Halibut will be tagged for the purpose of obtaining information as to their migrations; and biological, statistical, and economic studies will be carried on. The information derived from such studies will be used as the basis for future regulation and conservation of this valuable fishery.

Only landings at Alaskan ports are shown in the statistics for the Alaska halibut industry, and hence do not represent the entire catch from the banks off the coast of Alaska, as large quantities are landed at ports in British Columbia as well as at Seattle. The landings in Alaska totaled 10,971,651 pounds, valued at $884,383, a decrease of 4,065,965 pounds and $735,060 from 1924, or about 27 per cent in quantity and 45 per cent in value. The total investment in the halibut industry in 1925 was $3,503,921, as compared with $2,316,084 in 1924. Persons engaged in this fishery in 1925 numbered 861, as compared with 633 in the preceding year.

Persons engaged, investment, and products of the Alaska halibut fishery in 1925

Items	Southeast Alaska		Central Alaska		Total	
PERSONS ENGAGED	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*
Whites	838		15		853	
Natives	8				8	
Total	846		15		861	
INVESTMENT						
Shore property		$336,838		$25,000		$361,838
Operating capital		1,010,799		34,594		1,045,393
Vessels:						
Power, over 5 tons	166	1,800,000			166	1,800,000
Net tonnage	3,478				3,478	
Launches	119	249,500			119	249,500
Dories	151	6,040			151	6,040
Apparatus: Trawls	833	41,150			833	41,150
Total		3,444,327		59,594		3,503,921
PRODUCTS (POUNDS)						
Fresh (including local)	3,231,214	300,008	18,015	1,992	3,249,229	302,000
Frozen	6,405,864	513,058	1,316,558	69,325	7,722,422	582,383
Total	9,637,078	813,066	1,334,573	71,317	10,971,651	884,383

COD

In Alaskan waters, cod fishing is conducted both from shore stations and by an offshore fleet that operates entirely from ports in the States. In the following statistics Alaska is credited only with the operations from shore stations and with vessels that land their catches in Alaska or engage in transporting products from the shore stations. In 1925, the shore-station cod fleet consisted of 4 vessels belonging to the Union Fish Co., 2 of the Alaska Codfish Co., and 1 of the San Juan Fishing & Packing Co. The offshore fleet, which is listed separately, comprised 4 vessels of the Union Fish Co., 3 of the Pacific Coast Codfish Co., 2 of the Robinson Fisheries Co., 1 of the Alaska Codfish Co., and 1 belonging to Capt. J. A. Matheson. The only addition to the fleet in 1925 was the schooner *C. A. Thayer* (390 tons), which was acquired by the Pacific Coast Codfish Co. and was sent to Bering Sea early in the year. The *Daisy*, which belonged to the Aleutian Islands Livestock Co. at Chernofsky, Alaska, did not fish for cod in 1925.

STATISTICAL SUMMARY

The cod industry of Alaska gave employment to 113 persons in 1925, or 11 more than in 1924. The investment amounted to $467,530, as compared with $310,792 in 1924. Dry-salted and pickled cod, stockfish, tongues, and frozen cod, aggregating 2,853,942 pounds, valued at $128,803, were the products of this fishery. Comparable figures for 1924 are 1,580,026 pounds, valued at $100,777. The products of the offshore fishery were reported to be 10,560,546 pounds of dry-salted cod and tongues, valued at $573,170. The offshore fishery employed 344 persons.

Persons engaged, investment, and products of Alaska cod industry in 1925

Items	Southeast Alaska		Central Alaska		Western Alaska		Total	
PERSONS ENGAGED								
Fishermen:	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*
Whites			90		9		99	
Natives			2				2	
Japanese			1				1	
Total			93		9		102	
Shoresmen: Whites			6				6	
Transporters: Whites			5				5	
Grand total			104		9		113	
INVESTMENT								
Shore stations			14	$164,384	1	$2,000	15	$166,384
Operating capital				63,820		8,429		72,249
Wages paid				65,392		4,376		69,768
Vessels:								
Power, over 5 tons			3	19,200	1	2,500	4	21,700
Net tonnage			58		14		72	
Sailing			3	66,819			3	66,819
Net tonnage			874				874	
Launches			15	46,100			15	46,100
Power dories			60	21,050			60	21,050
Rowboats			29	1,350	5	150	34	1,500
Apparatus:								
Trawl lines			22	1,410			22	1,410
Fathoms			7,210				7,210	
Hand lines			743	550			743	550
Total				450,075		17,455		467,530
PRODUCTS (POUNDS)								
Dry-salted cod			2,551,164	108,783	178,685	10,721	2,729,849	119,504
Stockfish			36,718	7,226			36,718	7,226
Tongues			1,750	170			1,750	170
Frozen	75,225	$1,128					75,225	1,128
Pickled	10,400	775					10,400	775
Total	85,625	1,903	2,589,632	116,179	178,685	10,721	2,853,942	128,803

Alaska shore-station cod fleet in 1925

Name	Rig	Net tonnage	Operators
Golden State	Power schooner	223	Union Fish Co., San Francisco, Calif.
Pirate	Power sloop	30	Do.
Union Flag	do	7	Do.
Mary G	do	21	Do.
City of Papeete	Schooner	370	Alaska Codfish Co., San Francisco, Calif.
Glendale	do	281	Do.
San Jose	Power vessel	14	San Juan Fishing & Packing Co., Seattle, Wash.

Offshore cod fleet in 1925

Name	Rig	Net tonnage	Operators
Maweema	Schooner	392	Alaska Codfish Co., San Francisco, Calif.
Fanny Dutard	do	252	J. A. Matheson, Anacortes, Wash.
John A	do	235	Pacific Coast Codfish Co., Seattle, Wash.
Charles R. Wilson	do	328	Do.
C. A. Thayer	do	390	Do.
Wawona	do	413	Robinson Fisheries Co., Anacortes, Wash.
Alice	do	220	Do.
Louise	do	223	Union Fish Co., San Francisco, Calif.
Beulah	do	328	Do.
Galilee	do	339	Do.
Progress	Power schooner	115	Do.

WHALES

The North Pacific Sea Products Co. again operated its plant at Akutan, Alaska, using six steam whalers during the season. Employment was given to 121 whites and 24 natives. The company took 496 whales in all, consisting of 233 finbacks, 193 humpbacks, 36 sulphur bottoms, 33 sperm, and 1 right whale. Capt. Louis L. Lane, with the *Gunnar*, also engaged in capturing whales in Prince William Sound and Cook Inlet and around Kodiak Island for sale as fox food to ranches along the coast. He disposed of 1 finback and 15 humpbacks in this way.

The investment in the commercial whale fishery was $545,074 and the products were as follows: 848,850 gallons of whale oil, valued at $509,310; 114,400 gallons of sperm oil, valued at $46,637; 1,069 tons of fertilizer from meat, valued at $53,372; 153 tons of bone fertilizer, valued at $3,927; 127,149 pounds of pickled meat, valued at $6,113; and 16 whale carcasses, valued at approximately $5,600, a total value of products of $624,959, or an increase of 59.5 per cent over 1924 when products were valued at $391,781.

CLAMS

H. C. McMillin, who assisted Dr. F. W. Weymouth in an extensive survey of the clam beds in Alaska in 1924, was in the Cordova district again for a short time in the 1925 season. The following discussion of conditions is taken from his report:

The season of 1925 has been very much better than was anticipated. Large clams showed well throughout the early part of the season and until I left the beds on July 9. The pack is somewhat larger than we expected, but it was obtained from large-sized mature clams.

The present regulation [4½-inch minimum] has been a benefit to the canneries and diggers alike, although there are some statements to the contrary. It is evident that large clams are handled more easily, but the main benefit that I have observed is the lack of waste. Last year [1924 season] great numbers of small clams were lost through the screens at the weigh scows, some were thrown out with the shells, and still more were wasted by the cleaners. Clams shrink during the scalding process to such an extent that those less than the present legal size can not be handled without waste.

The catch of 1925 has been handled efficiently. The number of small clams, less than 4½ inches, has been very limited, due to two things: (1) The good showing of large clams, and (2) the present size limit. As some sections of the beds would produce small clams on unfavorable tides, the greater credit belongs to the latter.

While the present pack is more than the beach will support, it is a material reduction from former years, and further reductions can be looked for in the future. In the steady decrease of the annual catch on the Washington beds there are records of good years in which large clams appeared in numbers. These seasons were followed by poor years, due to the reduced number of mature clams. If this can be compared with Cordova, the future pack will be reduced to what the beds can support by the operation of the present size limit.

The size limit of 4½ inches was fixed after a careful study of the natural history of the animal, and further work on the maturity has more than justified the conclusion of those who determined it. Under the protection of this limit every clam is allowed to mature and spawn at least once. A reduction in the size limit would very seriously impair its usefulness.

As has been stated before, some sections of the beach have been closed by the present limit. It has worked far better than closure by geographical boundaries which would be impossible to describe and would change as bars and channels shift. It also allows the diggers to operate during the lowest tides on beaches that would otherwise be closed.

A bureau employee was specially assigned to supervise operations in the Cordova district during the season and to see that the new regulations were complied with fully. His report contained the following reference to the character and extent of operations:

Digging operations are conducted on the clam beds near Cordova and Point Whitshed, along the beach from Eyak River Channel, outside of Egg Islands, Hook Point, Point Steele, Point Bentinck, Boswell Bay, Hawkins Cutoff, Mummy Islands, and Orca Inlet.

The clam beds above mentioned cover about 400 square miles, and about 200 men dig in this area. The seven operating companies cover almost the entire section.

The clams vary in size, color, and flavor. West and south of Mummy Island they are large and somewhat tough. The shell is dark, due to mud and sand bars. East of the territory between Twin Rocks and Egg Island the clams are tender, light yellow in color, and have striped yellow shells. Clams found to the east and off of Egg Island, Point Hook, and Point Steele have a better flavor than those that occur at these places. These clams are not as large or dark as those near Hawkins Cutoff. But few large clams are found on the high bars, because, being the most accessible, these have been dug over so much. However, at low tide, or when the tide is as much as 2 feet higher than the minimum, large clams appear in great quantities, especially if the weather is warm and bright.

STATISTICAL SUMMARY

Ten firms in central and one in southeastern Alaska packed clams. The investment in the industry was $672,244, all of which was in the central district. Operations centered at Cordova, in the vicinity of which place seven concerns were located, Kukak Bay, Bering River, and Cook Inlet each having one operator. The number of persons engaged in the industry was 623, of whom 593 were whites, 16 natives, 10 Chinese, 3 Filipinos, and 1 Mexican. The investment in 1924 was $707,970, and 729 persons were engaged in the industry. The output in 1925 was 75,279 cases, containing 2,065,554 pounds, valued at $492,051, a decrease of about 12 per cent in quantity and 22 per cent in value from 1924, when 83,161 cases, valued at $629,412, were packed. The smaller pack in central Alaska was attributable largely to the strike of clam diggers, which continued for nearly three weeks in May during the height of the season.

Products of the Alaska clam industry in 1925

Items	Cases	Pounds	Value
Minced:			
½-pound cans (48 to case)	47,248	1,133,952	$264,376
10-ounce cans (48 to case)	22,330	669,900	187,214
Whole:			
½-pound cans (48 to case)	50	1,200	300
1-pound cans (48 to case)	5,054	242,592	36,803
5-pound cans (6 to case)	597	17,910	3,358
Total	75,279	2,065,554	492,051

SHRIMP

The bureau continued its investigation of the shrimp fishery in 1925, and two employees were detailed to accompany prospecting expeditions of the Alaskan Glacier Sea Food Co. in April, during the closed season on commercial operations. Warden Frank W. Hynes

was on a vessel that worked in Keku Strait, Port Beauclerc, Shakan Strait, El Capitan Passage, Cleveland Passage, Port Houghton, Seymour Canal, and Gambier Bay. While shrimp were found almost everywhere, they were not numerous enough to warrant commercial operations.

Another boat, with Special Warden P. C. Dalgard on board, worked around Sullivan Island, in the Haines district, and in Chilkat Inlet. In the Sullivan Island district and in Chilkat Inlet the shrimp were small and immature—a mixture of various species, with the pinks predominating. In the Haines district they were older and considerably larger in size, and the pinks predominated, constituting about 90 per cent of the catch.

The Alaskan Glacier Sea Food Co. later operated a floating plant for a few months at Haines, but the frequent storms in Lynn Canal were found to handicap the work.

In these districts the closed season, which extends from March 15 to April 30, and the spawning period seem to be identical.

In 1924 and 1925 information in regard to the habits of shrimp was secured. Investigations in 1924 showed that the larger varieties—the spot, coon, and sidestripe—each produce about 4,000 eggs, while the smaller species—the pink, humpback, and California—produce about half that many. The spawn is to be seen first in October. Some observers hold that the shrimp spawn in comparatively shallow water (10 to 15 fathoms deep) on mud bottom, where the eggs hatch in from one to two weeks. Others believe that they spawn in deep water, on rocky reefs, and among the tree corals, where they are protected from the trawls. An investigation of the shrimp fishery will be made in 1926 to secure more definite information on this subject. While shrimp are found virtually throughout the waters of southeastern Alaska, in many cases they do not occur in paying quantities, or else the very rough and rocky bottom prevents the successful use of trawls. It is reported that the most economical form of apparatus is the large beam trawl, the otter trawl used in shrimp fisheries elsewhere not having been found to be successful in Alaska.

During 1925 commercial operations were conducted as usual in the Petersburg and Wrangell districts, where shrimp were found in plentiful quantities.

The investment in the shrimp industry in 1925 was $318,353, as compared with $326,683 in 1924. Of this total, $6,000 represents the value of plants, $250,253 cost of operations and wages, and $62,100 value of boats and apparatus. Employment was given to 146 persons, of whom 35 were whites, 76 natives, 1 Chinese, 15 Japanese, 12 Filipinos, 5 Mexicans, and 2 Negroes. Products consisted of 519,535 pounds of shrimp meat, valued at $207,315, as compared with 528,432 pounds, valued at $227,979 in 1924, a decrease of approximately 2 per cent in quantity and 9 per cent in value.

CRABS

Crab products were prepared at four plants in southeastern Alaska—the Alaskan Glacier Sea Food Co. (which handled chiefly shrimp), the Northern Seafoods Co., and the Star Shellfish Co., all at Petersburg; and the Northern Fishing Co., formerly the Dobbins

Packing Co., at Hoonah. A small amount of crabs also was canned at the salmon cannery of the Alaska Year-Round Canneries Co., at Seldovia, in the central district.

The total investment, all in the southeastern district, was $59,872, and 29 whites and 6 natives were employed. The output consisted of 124,805 pounds of cold-packed crab meat, valued at $49,185; 2,200 dozen crabs in the shell, valued at $3,572; and 87 cases of 1-pound cans, valued at $600. The total value of products in 1925 was $53,357, as compared with $48,727 in 1924, a gain of 9.5 per cent.

TROUT

There was no separate investment for handling trout in Alaska in 1925, all operations being incidental to other branches of the fisheries. The products were as follows: Dolly Vardens, 13,370 pounds frozen, valued at $1,093; 31,309 pounds fresh, valued at $4,566; and 5 barrels pickled, valued at $60; a total of 45,679 pounds, valued at $5,719; steelheads, 6,973 pounds frozen, valued at $343, and 500 pounds fresh, valued at $75, a total of 7,473 pounds, valued at $418. The total production of both species was 53,152 pounds, valued at $6,137. No trout were canned. The production in 1924 was 61,262 pounds, valued at $6,741.

MISCELLANEOUS FISHERY PRODUCTS

Minor species of fish are taken in small quantities, chiefly in connection with the halibut fishery. In 1925 such products were as follows: Sablefish, 190,517 pounds fresh, valued at $7,477; 731,912 pounds frozen, valued at $30,971; and 120,096 pounds pickled, valued at $6,388; rockfishes, 23,936 pounds fresh, valued at $490; smelt, 23,420 pounds frozen, valued at $2,342; "lingcod," 30,736 pounds fresh, valued at $615; flounders, 10,835 pounds frozen, valued at $108.

FUR-SEAL INDUSTRY

PRIBILOF ISLANDS

GENERAL ADMINISTRATIVE WORK

In the calendar year 1925, 19,860 fur-seal skins were taken on the Pribilof Islands, of which 15,082 were taken on St. Paul Island and 4,778 on St. George Island. Seven thousand one hundred and thirty-three of the sealskins taken were blubbered before being salted, this number being somewhat smaller than in the last few years. Careful attention was given to the improved method of feeding foxes recently put into practice, which should greatly increase the production of fox skins within the next few years. The by-products plant on St. Paul Island was not operated, as a sufficient quantity of oil and meal to meet the bureau's immediate requirements was on hand.

Several concrete houses were constructed on St. Paul Island for occupancy by the natives. The new water-supply systems on St. Paul and St. George Islands were so nearly completed that it was possible to operate them. The construction of necessary roads on St. Paul Island was greatly advanced.

Through the courtesy of the Navy Department, the general supplies for the season were transported from Seattle to the Pribilof Islands by the U. S. S. *Vega*. Minor supplies were transported by commercial vessels and by the United States fisheries schooner *Eider*.

The United States Coast Guard maintained an efficient patrol for the protection of fur seals in the waters surrounding the Pribilof Islands as well as those waters that are frequented by the seals in their spring migration. The bureau is under obligation to the Coast Guard for many services rendered in connection with administrative work at the Pribilofs.

PURCHASE AND TRANSPORTATION OF SUPPLIES

On May 31, Assistant Agent Albert K. Brown left the Washington office for Seattle to purchase and ship the annual supplies for the Pribilof Islands and the *Eider*. With the exception of small shipments made at various times, transportation from Seattle to the islands, through the courtesy of the Navy Department, was afforded on the U. S. S. *Vega*. The vessel left Seattle on July 31 and arrived at St. Paul Island on August 10. The conditions for handling cargo at the Pribilofs were favorable, and the *Vega* left St. George Island on August 25 and arrived at Bremerton, Wash., on September 1. The annual supplies for the power vessel *Eider* were transported by the *Vega* with the island supplies. All of these supplies amounted to about 1,600 tons of miscellaneous freight and 158,000 feet of lumber.

Minor shipments for the Pribilof Islands and the *Eider* were made from Seattle. In April about 20 tons of food materials were forwarded

on the steamship *Cordova*, and in May about 30 tons more were forwarded by the same vessel. In October about 50 tons were forwarded by a commercial steamer.

POWER SCHOONER "EIDER"

The *Eider* left Seattle in February for the Pribilof Islands and was employed thereafter in connection with fur-seal and salmon work until the latter part of November, when it arrived at Seattle to undergo general overhauling.

On the trip from Seattle to Alaska the vessel struck a rock in Wrangell Narrows. Some damage was done, and while temporary repairs made it feasible to continue the season's work it was found impracticable to make final repairs until the vessel returned to Seattle in the fall.

In March a trip was made to the Pribilof Islands, and in April the vessel engaged in transporting emergency supplies, mail, and passengers from False Pass and King Cove to the Pribilofs. In May perishable foodstuffs shipped on the steamship *Cordova* from Seattle to False Pass were delivered to the Pribilofs by the *Eider*, and a number of temporary native workmen also were transferred to the Pribilofs from Unalaska.

In June, July, and August the vessel was engaged actively in fur-seal work and in furnishing transportation to employees conducting the salmon work of the bureau. In September the vessel delivered at Yakutat and Juneau a number of blue foxes from the Pribilof Islands. In October perishable foodstuffs shipped on the steamship *Alameda* from Seattle to Unalaska were delivered to the Pribilofs. This work was completed in November, and the vessel then proceeded to Seattle, stopping at various places en route. At Yes Bay 34 cases of salmon eggs were taken aboard for delivery at Seattle.

In August a 12-horsepower Cummins Diesel auxiliary engine was installed in the vessel.

ROADS

Considerable road work was done on St. Paul Island. A number of natives from Unalaska were hired, and resident natives were employed whenever their services could be spared from other duties. The appropriation covering general work at the Pribilof Islands in the fiscal year 1926 authorized the expenditure for road building of not to exceed $10,000.

Ever since the bridge at Halfway Point became unfit for use the inconvenient method of crossing the slough at that point has made transportation between Northeast Point and the village difficult. In 1925 a large fill of sand was thrown across the slough. A large amount of work was necessary, as the material used had to be moved by wheelbarrows. To protect the fill from wind and water, it was sodded on both sides, with the exception of a portion of one side, which will be finished next year.

Progress was made on the road between the village and Zapadni. Roads in the village, as well as that through Lukanin flats, were resurfaced with scoria.

CONSTRUCTION OF BUILDINGS

Native dwellings.—Twelve concrete dwellings for the use of natives were begun on St. Paul Island. The work on 10 of these was so nearly finished by the end of the year that they should be ready for occupancy early in 1926. Foundations for the other two were completed. Nine of these dwellings contain four rooms each, and three have five rooms each. These buildings have 6-inch concrete walls reinforced with steel bars.

Dispensary.—The new dispensary on St. Paul Island, which was begun in 1924, was completed and occupied in 1925. The building, which is well equipped, includes a laboratory and living quarters for theresident physician.

FIG. 12.—Road construction, St. Paul Island

Barns.—The foundation for a barn for domestic livestock was laid at St. Paul Island. Work on a new barn also was begun on St. George Island. The existing barns on both islands were built many years ago by lessees of the islands and have become unfit for use.

Employees' dwellings.—A dwelling to be used mainly by the schoolteachers was begun on St. George Island.

WATERWORKS

St. Paul Island.—On St. Paul Island the project of supplying water to the village from Ice House Lake had progressed so far that it was possible to operate the plant. A permanent filter at the lake remained to be constructed, and the laying of pipes to various parts of the village was not completed.

St. George Island.—The new waterworks system was completed and placed in operation. Water from Upper Lake is filtered and pumped into tanks, from which it flows by gravity to the village.

BY-PRODUCTS PLANT

The by-products plant on St. Paul Island was not operated in 1925, as sufficient oil and meal were on hand to provide fox feed and take care of other requirements for some time.

FIG. 13.—New type of concrete house for natives under construction, St. Paul Island

In August surplus oil was shipped from the plant to Bremerton, Wash., on the U. S. S. *Vega*. This oil, which amounted to 1,018.6 gallons, was sold for 55 cents per gallon, or $560.23. After deducting freight charges from Bremerton, Wash., to Richmond, Calif., amounting to $54.49, the remainder ($505.74) was transferred to the general fund of the United States Treasury.

INTRODUCTION OF LEMMINGS, ST. PAUL ISLAND

Late in June six male and six female black-footed lemmings were transferred from St. George Island to St. Paul Island and liberated at Lake Hill, where investigation showed they were establishing themselves. The experiment will be watched with interest.

So far as known, lemmings of this species are found only on St. George Island. It is understood that their introduction on St. Paul Island was attempted on two previous occasions without success.

NATIVES

CENSUS

The annual census, taken as of December 31, 1925, showed 184 natives resident on St. Paul Island and 138 on St. George Island. In

addition some natives who should be accredited to the islands were away temporarily at the Salem Indian Training School at Chemawa, Oreg., and elsewhere.

During the year there were 10 births and 3 deaths on St. Paul Island and 3 births and 4 deaths on St. George Island.

MEDICAL SERVICES

Two physicians were detailed to the islands throughout the year, and a dentist for the islands arrived at St. Paul Island on April 27. He stayed at the islands throughout the remainder of the year, and it is planned to have him continue until all needed dental work is completed.

SCHOOLS

St. Paul Island.—The 1924–25 school year began on September 8, 1924, with an enrollment of 13 boys and 10 girls in the senior school and 13 boys and 17 girls in the junior school, a total of 53 children. The term ended on May 1, 1925.

St. George Island.—The 1924–25 school year began on September 15, 1924, with an enrollment of 40 pupils. On October 20 a number were transferred to the junior school, which opened on that date. The school term ended May 19, 1925.

ATTENDANCE AT SALEM INDIAN TRAINING SCHOOL, CHEMAWA, OREG.

On January 1, 1925, 11 natives of St. Paul Island (8 boys and 3 girls) were in attendance at the Salem Indian Training School at Chemawa, Oreg. Three of the boys returned to their homes on St. Paul Island in the year. A fourth, Nicolai Stepetin, secured employment on the Bureau of Education's vessel, *Boxer*, during his summer vacation, and was drowned while swimming at Kotzebue, Alaska, in August. The remaining seven children were still in attendance at the school at the close of the year.

SAVINGS ACCOUNTS

Certain of the Pribilof Island natives have funds in the custody of the United States Commissioner of Fisheries. Throughout 1925 these funds were kept on deposit with the Washington Loan & Trust Co., Washington, D. C., and interest was paid at the rate of 3 per cent per annum, calculated on monthly balances. New accounts for eight natives were opened and four were closed during the year. A summary of the accounts as a whole for the year 1925 is shown in the statement that follows:

On hand, Jan. 1, 1925		$11,519.46
Interest earned from Jan. 1 to Dec. 31, 1925		337.17
Deposited by natives in 1925		490.57
		12,347.20
Withdrawn by natives in 1925		919.35
On hand, Dec. 31, 1925		11,427.85

An itemized statement of the account, showing the individual accounts, follows:

Savings accounts of the Pribilof Islands natives in the custody of the United States Commissioner of Fisheries, as trustee, December 31, 1925

Borenien, Zoya [1]	$273.68
Bourdukofsky, Martha	104.79
Bourdukofsky, Peter	.90
Fratis, Agrippina [2]	107.68
Fratis, Akalina [2]	521.85
Fratis, Martha [2]	107.66
Fratis, Iuliania [2]	107.66
Galanin, Mary	38.82
Gromoff, Iuliana	295.25
Kochutin, Alexandra	4,422.75
Krukoff, Ekaterina	108.13
Lekanof, Sophia M. [3]	476.20
Lestenkof, Michael	313.80
Mandregan, Alexandra M	11.79
Melovidov, Anton	4.22
Merculieff, Desofey [2]	44.74
Merculieff, Makary	44.74
Merculieff, Mariamna [2]	74.61
Merculief, Agrippina	21.18
Merculief, Alexandra [3]	476.20
Merculief, Daniel [3]	558.00
Merculief, Erena [3]	558.00
Merculief, George [3]	476.25
Merculief, jr., George [3]	476.20
Merculief, Joseph	200.13
Merculief, Nicolai G. [3]	440.80
Merculief, Polyxenia	127.81
Merculief, Tatiana [3]	558.00
Pankoff, Agrippina	152.10
Pankoff, Maria M(elovidov)	49.96
Sedick, Lavrenty	55.54
Sedick, Leonty	55.54
Sedick, Marina	.38
Shane, Michael	99.22
Tetoff, Vikenty M(elovidov)	62.82
Zacharof, Emanuel	.45

PAYMENTS FOR TAKING SEALSKINS

For taking sealskins the natives of the Pribilof Islands were paid in cash. Seventy-five cents was paid for each sealskin taken, and bonuses were given for special work. In distributing the amount earned on the basis of 75 cents per skin, the sealers were divided into classes according to their skill and ability, and a definite amount was fixed upon as payment for the individual members of each class. Payments were made as shown below.

[1] Deceased. [2] Not living on island in 1925. [3] New account.

St. Paul Island.—For the 15,082 sealskins taken on St. Paul Island $11,311.50 was paid, and in addition $100 was allowed two foremen for special services. A statement of the earnings follows:

Payments to St. Paul Island natives for taking sealskins, calendar year, 1925

Classification	Number of men	Share of each	Total
First class	27	$269.25	$7,269.75
Second class	8	213.75	1,710.00
Third class	6	172.50	1,035.00
Fourth class	9	129.75	1,167.75
Fifth class	1	129.00	129.00
Foreman (additional compensation)			50.00
Do			50.00
Total			11,411.50

St. George Island.—For the 4,778 sealskins taken on St. George Island, $3,583.50 was paid, and in addition $100 was allowed two foremen for special services. Ten men that were temporarily detailed to St. Paul Island to assist with sealing operations also were paid $50 each for their work. A detailed statement of the earnings follows:

Payments to St. George Island natives for taking sealskins, calendar year 1925

Classification	Number of men	Share of each	Total
First class	19	$111.00	$2,109.00
Second class	10	88.50	885.00
Third class	1		67.50
Fourth class	8	65.25	522.00
Foreman (additional compensation)			55.00
Do			45.00
Additional amount paid for sealing work on St. Paul Island, 10 men at $50 each			500.00
Total			4,183.50

PAYMENTS FOR TAKING FOX SKINS

For taking, curing, and shipping fox skins on the Pribilof Islands, the Government paid the natives $5 for each pelt. For the 107 skins taken on St. Paul Island in the season of 1924–25 $535 was paid, each individual native receiving payment in proportion to the number of skins taken by him. For the 602 skins taken on St. George Island in the season of 1924–25 payments totaling $3,010 were made. On this island the work is carried on by the natives as a whole, rather than as individuals, and payments are made to individuals in accordance with what is considered a proper distribution.

FUR-SEAL HERD

QUOTA FOR KILLING

The Acting Secretary of Commerce approved the bureau's recommendation that after 9,000 3-year-old male seals had been set aside for breeding purposes (7,200 on St. Paul Island and 1,800 on St. George), as many 3-year-old males as could be obtained should be killed.

KILLINGS OF SEALS

In 1925, 19,860 seals were killed on both islands (including 2 seals found dead, the skins from which were preserved for commercial purposes), of which 15,082 were taken on St. Paul and 4,778 on St. George Island. Of these, 18,337 were from 3-year-old males. Details with regard to the age classes of the seals killed are shown on page 148.

Seal killings on Pribilof Islands in 1925

ST. PAUL ISLAND

Date	Serial No. of drive	Hauling ground	Skins secured
May 8	1	Sea Lion rock	47
June 1	2	do	136
June 13		Seals killed for food	2
June 16		From seals that died as a result of shearing.	5
June 17		From seal found dead	1
June 19		From seals that died as a result of shearing.	2
Do		Seal killed for food	1
June 21	3	Gorbatch	47
June 22		Lukanin	2
June 24		From seals killed for food	2
June 27	4	Gorbatch	73
July 1	5	Tolstoi and Lukanin	189
July 2	6	Reef and Gorbatch	516
July 4	7	Polovina	214
July 6	8	Tolstoi and Lukanin	401
July 7	9	Reef and Gorbatch	1,256
July 8	10	Zapadni and Little Zapadni.	400
July 9	11	Polovina	298
July 10		From seal that died as a result of shearing.	1
July 11	12	Tolstoi and Lukanin	496
Do		From seals that died as a result of shearing.	3
July 12	13	Reef and Gorbatch	1,144
July 13	14	Zapadni and Little Zapadni.	577
July 14	15	Polovina	110
Do	16	Vostochni	350
July 15	17	Vostochni and Morjovi	737
July 16	18	Tolstoi, Lukanin, and Kitovi.	721
July 17	19	Reef and Gorbatch	1,391
July 18	20	Zapadni and Little Zapadni.	348
July 19	21	Polovina	235
July 20	22	Vostochni and Morjovi	531
July 21	23	Tolstoi, Lukanin, and Kitovi.	452
July 22	24	Reef and Gorbatch	1,279
July 23	25	Zapadni and Little Zapadni.	137
July 24	26	Polovina	110
Do	27	Vostochni	330
July 25	28	Vostochni and Morjovi	492
July 26	29	Tolstoi, Lukanin, and Kitovi.	319
July 27	30	Reef and Gorbatch	493
July 28	31	Zapadni and Little Zapadni.	202
July 29	32	Polovina	64
July 31	33	Reef and Gorbatch	419
Aug. 3		From seals killed for food	3
Sept. 18		From seal found dead	1
Oct. 20	34	Reef and Gorbatch	160
Oct. 22	35	Tolstoi, Lukanin, and Kitovi.	120
Oct. 23	36	Zapadni and Little Zapadni.	45
Oct. 24	37	Vostochni and Morjovi	220
		Total	15,082

ST. GEORGE ISLAND

July 9	1	Staraya Artil	25
June 17	2	East Cliffs	92
July 1	3	do	72
July 6	4	do	194
July 7	5	North and Staraya Artil	354
July 11	6	do	83
July 14	7	East Reef and East Cliffs	185
July 15	8	North and Staraya Artil	874
July 18	9	East Reef and East Cliffs	355
July 20	10	North and Staraya Artil	658
July 23	11	East Reef and East Cliffs	216
July 24	12	North and Staraya Artil	580
July 27	13	East Reef and East Cliffs	129
July 28	14	North and Staraya Artil	316
July 29	15	Zapadni	41
July 31	16	North, East Reef and East Cliffs.	380
Aug. 27	17	North	10
Oct. 23	18	do	51
Nov. 3	19	do	110
Nov. 23	20	Staraya Artil	33
Nov. 25	21	North	20
		Total	4,778

AGE CLASSES OF SEALS

The age class of a male seal belonging to the Pribilof Islands herd is determined from the length of its body. The classification was derived from measurements of a large number of pups branded in 1912 and killed in subsequent years. The limits of the various age classes are shown in the table following:

Age classes of male seals, Pribilof Islands

Age	Length of summer seals	Length of fall seals	Age	Length of summer seals	Length of fall seals
	Inches	*Inches*		*Inches*	*Inches*
Yearlings	Up to 36.75	Up to 38.75	4-year-olds	46 to 51.75	48 to 53.75
2-year-olds	37 to 40.75	39 to 42.75	5-year-olds	52 to 57.75	54 to 59.75
3-year-olds	41 to 45.75	43 to 47.75	6-year-olds	58 to 63.75	60 to 65.75

Ages of seals killed on Pribilof Islands, calendar year 1925

Age	Summer (Jan. 1 to Aug. 5)			Fall (Aug. 6 to Dec. 31)			Total for year		
	St. Paul	St. George	Total	St. Paul	St. George	Total	St. Paul	St. George	Total
Yearling males	8		8	1		1	9		9
2-year-old males	931	22	953	26		26	957	22	979
3-year-old males	13,129	4,483	17,612	501	224	725	13,630	4,707	18,337
4-year-old males	385	24	409	11		11	396	24	420
5-year-old males	2		2				2		2
6-year-old males		1	1					1	1
7-year-olds and older, males	2		2				2		2
Cows [1]	79	24	103	7		7	86	24	110
Total	14,536	4,554	19,090	546	224	770	15,082	4,778	19,860

[1] Cows unavoidably and accidentally killed or found dead.

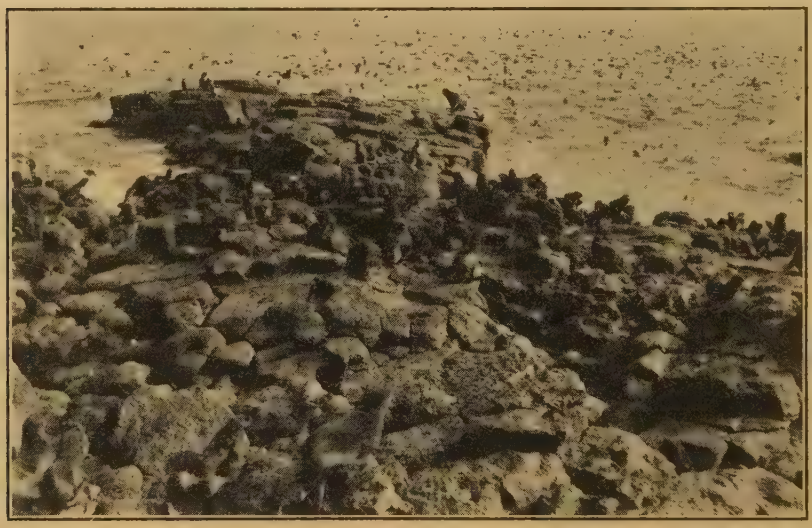

FIG. 14.—Fur-seal rookery, St. Paul Island

RESERVING OPERATIONS

The marking of male seals to be reserved for future breeding began on June 11 and ended on July 31. In this period, 15,002 seals, of which 9,354 were 3-year-olds, were marked and released. The remaining 5,648 seals were 4 and 5 years old.

On St. Paul Island, marking began on June 11 and ended on July 31, during which time 7,424 3-year-olds, 2,276 4-year-olds, and 2,212 5-year-olds were marked.

On St. George Island, operations began on June 16 and ended on July 22. During this period 1,930 3-year-olds, 642 4-year-olds, and 518 5-year-olds were marked.

The breeding reserve was increased only by the number of 3-year-olds marked. The other seals were marked only in order that data in regard to the return of older animals might be obtained.

On St. George Island, 800 3-year-olds were branded with a hot iron in order to secure data later. The other 14,202 animals were marked by shearing a patch of fur.

Further details in regard to the reserving operations are shown in the following table:

Breeding reserve seals marked, Pribilof Islands, 1925

Description of seals and method of marking	St. Paul Island	St. George Island	Total
3-year-old males, sheared	7,424	1,130	8,554
3-year-old males, branded with hot iron		800	800
4-year-old males, sheared	2,276	642	2,918
5-year-old males, with hot-iron brand of 1923, sheared	1,151	374	1,525
5-year-old males, without hot-iron brand of 1923, sheared	1,061	144	1,205
Total	11,912	3,090	15,002

CENSUS

In 1925, the census of the Pribilof Islands fur-seal herd was again taken by Edward C. Johnston, who, beginning with 1921, has had charge of the census work. Following is a comparative statement of the numerical strength of the various elements of the herd in the years 1914 to 1925, inclusive.

General comparison of recent censuses of the seal herd on the Pribilof Islands

Classes	1914	1915	1916	1917	1918	1919
Harem bulls	1,559	2,151	3,500	4,850	5,344	5,158
Breeding cows	93,250	103,527	116,977	128,024	142,915	157,172
Surplus bulls				8,977	17,110	9,619
Idle bulls	172	673	2,632	2,706	2,444	2,239
Young bulls (chiefly 5-year-olds)	1,658					
6-year-old males			11,167	15,397	13,755	8,991
5-year-old males		11,271	15,494	14,813	11,941	5,282
4-year-old males	9,939	15,848	15,427	16,631	7,114	5,747
3-year-old males	13,880	18,282	19,402	19,507	9,117	13,596
2-year-old males	17,422	23,990	24,169	26,815	30,159	33,081
Yearling males	23,068	30,307	33,645	38,013	41,595	46,444
2-year-old cows	17,422	23,990	24,245	26,917	30,415	33,287
Yearling cows	23,067	30,306	33,646	38,018	41,608	46,447
Pups	93,250	103,527	116,977	128,024	142,915	157,172
Total	294,687	363,872	417,281	468,692	496,432	524,235

Classes	1920	1921	1922	1923	1924	1925
Harem bulls	4,066	3,909	3,562	3,412	3,516	3,526
Breeding cows	167,527	176,655	185,914	197,659	208,396	226,090
Surplus bulls	6,115	3,301	2,346	1,891	2,043	3,558
Idle bulls	1,161	747	508	312	390	311
6-year-old males	4,153	3,991	3,771	4,863	8,489	4,105
5-year-old males	5,007	4,729	6,080	10,612	5,132	16,792
4-year-old males	5,667	6,780	11,807	5,710	18,670	18,692
3-year-old males	10,749	14,668	7,459	22,786	21,551	21,185
2-year-old males	39,111	41,893	40,920	43,112	45,685	43,515
Yearling males	51,074	50,249	52,988	55,769	59,291	52,091
2-year-old cows	39,480	43,419	46,280	48,801	51,359	49,786
Yearling cows	51,081	54,447	57,413	60,422	64,240	57,309
Pups	167,527	176,655	185,914	197,659	208,396	226,090
Total	552,718	581,443	604,962	653,008	697,158	723,050

DEVELOPMENT OF FOX HERDS ON PRIBILOF ISLANDS

FEEDING

St. Paul Island.—The feeding of foxes in the winter season of 1925–26 was begun on November 13 and continued as long as any lack of natural food made it desirable. The foxes were fed at stations established at various places on the island. At first the animals consumed very little, but as the winter grew more severe they ate more. With the approach of spring the quantity consumed was smaller. The food consisted of rice, rolled oats, wheat, seal meal, seal oil, and other ingredients, combined in suitable proportions and made into mush and biscuits. Except for short periods, considerable natural food was available on the beaches during the winter.

St. George Island.—Fox feeding was begun on November 9 by putting out biscuits and seal carcasses withdrawn from storage. About 500 biscuits and from 5 to 10 carcasses were consumed nightly. During a part of the fox-trapping season biscuits were not fed. At all times the foxes readily took the food offered and ate all of it. During the latter part of the season they seemed to prefer the biscuits to the somewhat salty seal carcasses. A well-preserved dead walrus was washed ashore at Garden Cove on February 16 and provided excellent food.

FOX-TRAPPING SEASON OF 1925–26

During the season 705 blue and 20 white fox pelts were taken on St. Paul and St. George Islands, a total of 725. The total number taken in the 1924–25 season was 709.

On St. Paul Island the regular trapping season began on December 13 and ended on December 20, 1925. In this period 66 blue and 17 white pelts were taken. Later, one blue pelt was secured from a fox found dead, and two pelts were secured from white foxes killed in accordance with the policy of eliminating as quickly as possible this color phase. Eighty-six pelts were secured during the season. Two hundred and eleven males and one hundred and fifty-five females were marked and released for breeding.

On St. George Island 638 blue pelts and 1 white pelt were taken during the season, and 216 males and 215 females were marked and released for breeding.

The breeding reserve thus established on each island was augmented, of course, by the number of animals that remained uncaptured in the course of the foxing season.

REINDEER

At the end of 1925 the number of reindeer on St. Paul Island was estimated to be 225, while on St. George Island 60 were on hand. During the year, 25 reindeer on St. Paul Island and 17 on St. George were killed for food.

FUR-SEAL SKINS

SHIPMENTS

In the calendar year 1925 one shipment of fur-seal skins was made from the Pribilof Islands. The shipment was made up of 19,478 skins, as follows: From St. Paul Island, 252 taken in the calendar year 1924 and 14,536 taken in 1925; from St. George Island, 136

taken in the calendar year 1924 and 4,554 taken in 1925. The skins were shipped from the islands in August on the U. S. S. *Vega*, which arrived at Bremerton, Wash., on September 1. From Bremerton the skins were shipped to St. Louis, Mo., via the Puget Sound Navigation Co., Great Northern Railway, and Chicago, Burlington & Quincy Railroad. They were delivered at St. Louis on September 17 and 18.

SALES

In 1925 a total of 17,211 fur-seal skins taken on the Pribilof Islands were sold at two public auction sales. There were sold at special sales, also, 139 fur-seal skins taken on these islands. In the detailed statements given below the sales of other sealskins sold by the Department of Commerce for the account of the Government are included in order that the records may be complete.

FIG. 15.—New warehouse, St. Paul Island

Public auction sale, May 25, 1925.—At this sale 8,025 dressed, dyed, and machined sealskins taken at the Pribilof Islands sold for $225,994; 3 dressed, dyed, and machined skins and 1 raw salted skin from seals shipped to the Steinhart Aquarium were sold for $47; and 1 raw-salted confiscated skin was sold for $2.50—a grand total of $226,043.50. Of the dressed, dyed, and machined skins, 5,842 were dyed black and 2,186 brown (Châtaigne d'Or).

Public auction sale, September 24, 1925.—At this sale, 9,186 dressed, dyed, and machined sealskins taken at the Pribilof Islands sold for $335,369.50; 60 dressed, dyed, and machined Japanese skins brought $567.50; 22 raw salted Japanese skins sold for $11; and 1 dressed, dyed and machined confiscated skin was sold for $20—a grand total of $335,968. Of the dressed, dyed, and machined skins, 8,299 were dyed black, 447 brown (Bois de Campêche), 60 brown (Châtaigne d'Or),

200 brown (dark Châtaigne d'Or), and 241 brown (light Châtaigne d'Or.)

The brown-dyed "Châtaigne d'Or" skins were introduced to the trade in 1924. The "Bois de Campêche," or logwood brown, skins were sold first at the sale of September 24, 1925. The average price obtained for the logwood brown skins was higher than the average obtained for skins dyed any other shade.

The 82 Japanese sealskins sold on September 24, 1925, were the United States' share of sealskins taken by the Japanese Government in 1923, delivered pursuant to the provisions of the North Pacific Sealing Convention of July 7, 1911.

Special sales.—In the calendar year 1925, 139 dressed, dyed, and machined sealskins were sold at special sales for $3,890.32. Of these skins, 57 were black dyed, 30 brown dyed (Châtaigne d'Or), and 52 brown dyed (Bois de Campêche).

The following tables give further details in regard to all sales of fur-seal skins by the Department of Commerce for the account of the Government in 1925:

Sale of fur-seal skins at St. Louis, Mo., May 25, 1925

5,839 DRESSED, DYED, AND MACHINED PRIBILOF ISLANDS SKINS, DYED BLACK

Lot No.	Number of skins	Trade classification	Price per skin	Total for lot	Lot No.	Number of skins	Trade classification	Price per skin	Total for lot
1	28	2 extra extra large; 26 extra large	$59.00	$1,652.00	37	90	Medium: scarred, blemished, faulty, etc	$26.50	$2,385.00
2	80	Large	42.00	3,360.00					
3	80	do	46.00	3,680.00	38	90	do	27.50	2,475.00
4	80	do	46.00	3,680.00	39	90	do	27.50	2,475.00
5	80	Large; scarred, blemished, faulty, etc	31.00	2,480.00	40	90	do	26.50	2,385.00
					41	90	do	27.00	2,430.00
6	80	do	29.00	2,320.00	42	60	do	26.50	1,590.00
7	90	Medium	33.00	2,970.00	43	56	do	26.00	1,456.00
8	90	do	33.00	2,970.00	44	90	Small medium	28.00	2,520.00
9	90	do	36.00	3,240.00	45	90	do	26.00	2,340.00
10	90	do	37.00	3,330.00	46	90	do	27.00	2,430.00
11	90	do	38.00	3,420.00	47	90	do	27.50	2,475.00
12	90	do	39.00	3,510.00	48	90	do	27.00	2,430.00
13	90	do	37.00	3,330.00	49	90	do	27.50	2,475.00
14	90	do	37.00	3,330.00	50	90	do	27.00	2,430.00
15	90	do	36.50	3,285.00	51	90	do	27.00	2,430.00
16	90	do	39.00	3,510.00	52	90	do	27.50	2,475.00
17	90	do	37.00	3,330.00	53	90	do	27.00	2,430.00
18	90	do	39.00	3,510.00	54	90	do	27.50	2,475.00
19	90	do	39.00	3,510.00	55	90	do	27.50	2,475.00
20	90	do	38.50	3,465.00	56	58	do	27.00	1,566.00
21	90	do	38.50	3,465.00	57	90	Small medium; scarred, blemished, faulty, etc	18.50	1,665.00
22	90	do	39.50	3,555.00					
23	90	do	40.00	3,600.00					
24	90	do	39.00	3,510.00	58	90	do	19.00	1,710.00
25	90	do	40.50	3,645.00	59	90	do	19.00	1,710.00
26	90	do	40.00	3,600.00	60	90	do	18.50	1,665.00
27	90	do	39.00	3,510.00	61	90	do	17.50	1,575.00
28	90	do	40.00	3,600.00	62	90	do	19.00	1,710.00
29	90	do	40.50	3,645.00	63	90	do	18.50	1,665.00
30	58	do	40.00	2,320.00	64	90	do	18.00	1,620.00
31	90	Medium; scarred, blemished, faulty, etc	25.00	2,250.00	65	90	do	17.50	1,575.00
					66	90	do	18.00	1,620.00
32	90	do	26.50	2,385.00	67	46	III; 6 large, 40 medium	12.50	575.00
33	90	do	26.00	2,340.00	68	50	III, small medium	11.00	550.00
34	90	do	26.00	2,340.00	69	43	do	11.00	473.00
35	90	do	27.00	2,430.00					
36	90	do	27.50	2,475.00		5,839			176,812.00

Sale of fur-seal skins at St. Louis, Mo., May 25, 1925—Continued

2,186 DRESSED, DYED, AND MACHINED PRIBILOF ISLANDS SKINS, DYED BROWN (CHÂTAIGNE D'OR)

Lot No.	Number of skins	Trade classification	Price per skin	Total for lot	Lot No.	Number of skins	Trade classification	Price per skin	Total for lot
71	23	4 extra large; 19 large	$41.00	$943.00	100	45	Medium; scarred, blemished, faulty, etc	$18.00	$810.00
72	56	2 extra large; 54 large	38.00	2,128.00	101	20	do	18.00	360.00
73	22	Large	45.00	990.00	102	20	do	20.00	400.00
74	34	Large; scarred, blemished, faulty, etc	35.00	1,190.00	103	29	Small medium	22.00	638.00
75	15	do	32.00	480.00	104	45	do	18.50	832.50
76	50	Medium	36.00	1,800.00	105	45	do	18.50	832.50
77	45	do	35.00	1,575.00	106	45	do	20.50	922.50
78	45	do	32.50	1,462.50	107	45	do	20.50	922.50
79	45	do	31.00	1,395.00	108	45	do	20.00	900.00
80	45	do	30.50	1,372.50	109	45	do	18.50	832.50
81	45	do	30.50	1,372.50	110	17	do	20.50	348.50
82	45	do	27.50	1,237.50	111	45	do	20.50	922.50
83	45	do	26.00	1,170.00	112	45	do	20.50	922.50
84	45	do	26.50	1,192.50	113	43	do	20.00	860.00
85	45	do	29.00	1,305.00	114	21	do	20.00	420.00
86	28	do	27.00	756.00	115	37	do	20.00	740.00
87	45	do	25.50	1,147.50	116	22	Small medium; scarred, blemished, faulty, etc	15.50	341.00
88	45	do	25.50	1,147.50					
89	45	do	25.50	1,147.50	117	45	do	14.00	630.00
90	23	do	27.00	621.00	118	45	do	14.50	652.50
91	21	do	25.50	535.50	119	45	do	14.00	630.00
92	43	do	26.00	1,118.00	120	45	do	14.00	630.00
93	45	Medium; scarred, blemished, faulty, etc	17.00	765.00	121	45	do	14.50	652.50
					122	45	do	14.00	630.00
					123	45	do	14.50	652.50
94	45	do	16.00	720.00	124	50	do	16.00	800.00
95	45	do	17.50	787.50	125	16	do	17.00	272.00
96	45	do	17.00	765.00	126	21	III; 14 medium, 7 small medium	11.00	231.00
97	45	do	16.00	720.00					
98	45	do	17.50	787.50					
99	45	do	17.00	765.00		2,186			49,182.00

4 SKINS TAKEN FROM PRIBILOF ISLANDS SEALS SHIPPED TO STEINHART AQUARIUM

70	3	Dressed, dyed, and machined, dyed black, III, small medium	$15.00	$45.00	131	1	Raw salted	$2.00	$2.00
						4			47.00

1 CONFISCATED SKIN

Lot No.	Number of skins	Trade classification	Price per skin	Total for lot
132	1	Raw salted	$2.50	$2.50

Sale of fur-seal skins at St. Louis, Mo., September 24, 1925

8,298 DRESSED, DYED, AND MACHINED PRIBILOF ISLANDS SKINS, DYED BLACK

Lot No.	Number of skins	Trade classification	Price per skin	Total for lot
1	66	14 extra large; 52 large	$58.50	$3,861.00
2	80	Large	48.00	3,840.00
3	80	do	51.00	4,080.00
4	80	do	50.50	4,040.00
5	80	do	51.00	4,080.00
6	80	do	56.50	4,520.00
7	55	Large; scarred, faulty, etc	36.00	1,980.00
8	90	Medium	38.00	3,420.00
9	90	do	39.00	3,510.00
10	90	do	42.00	3,780.00
11	90	do	43.50	3,915.00
12	90	do	44.00	3,960.00
13	90	do	42.50	3,825.00
14	90	do	44.50	4,005.00
15	90	do	44.50	4,005.00
16	90	do	47.00	4,230.00
17	90	do	45.50	4,095.00
18	90	do	47.00	4,230.00
19	90	do	46.50	4,185.00
20	90	do	48.00	4,320.00
21	90	do	48.00	4,320.00
22	90	do	48.50	4,365.00
23	90	do	48.50	4,365.00
24	90	do	49.50	4,455.00
25	90	do	50.00	4,500.00
26	90	do	50.50	4,545.00
27	90	do	51.50	4,635.00
28	90	do	52.00	4,680.00
29	90	do	52.50	4,725.00
30	90	do	53.00	4,770.00
31	90	do	52.50	4,725.00
32	90	do	53.00	4,770.00
33	90	do	52.50	4,725.00
34	90	do	53.00	4,770.00
35	90	do	52.50	4,725.00
36	68	do	53.00	3,604.00
37	90	Medium; scarred, faulty, etc	39.50	3,555.00
38	90	do	41.00	3,690.00
39	90	do	41.50	3,735.00
40	90	do	44.00	3,960.00
41	90	do	44.00	3,960.00
42	90	Small medium	40.00	3,600.00
43	90	do	40.00	3,600.00
44	90	do	40.50	3,645.00
45	90	do	40.00	3,600.00
46	90	do	40.00	3,600.00
47	90	do	39.50	3,555.00
48	90	do	40.50	3,645.00
49	90	do	40.00	3,600.00
50	90	do	40.50	3,645.00
51	90	do	40.50	3,645.00
52	90	do	40.50	3,645.00
53	90	do	40.00	3,600.00
54	90	do	39.50	3,555.00
55	90	Small medium	$41.00	$3,690.00
56	90	do	40.50	3,645.00
57	37	do	39.50	1,461.50
58	90	Small medium; scarred, faulty, etc	28.00	2,520.00
59	90	do	29.00	2,610.00
60	90	do	30.50	2,745.00
61	90	do	31.00	2,790.00
62	29	do	31.00	899.00
63	35	III; 1 large, 11 medium, 23 small medium	18.00	630.00
64	64	1 small wig, 1 extra extra large, 11 extra large, 51 large	44.00	2,816.00
65	64	Large	42.00	2,688.00
66	70	8 extra large; 62 large; scarred, faulty, etc	36.00	2,520.00
67	70	Large; scarred, faulty, etc	31.00	2,170.00
68	90	Medium	37.00	3,330.00
69	90	do	37.00	3,330.00
70	90	do	39.00	3,510.00
71	90	do	38.50	3,465.00
72	90	do	40.00	3,600.00
73	90	do	39.00	3,510.00
74	90	Medium; scarred, faulty, etc	22.50	2,025.00
75	90	do	22.00	1,980.00
76	90	do	20.00	1,800.00
77	90	do	18.00	1,620.00
78	90	do	16.50	1,485.00
79	90	do	17.50	1,575.00
80	90	do	21.00	1,890.00
81	90	do	17.50	1,575.00
82	90	do	20.50	1,845.00
83	50	do	21.00	1,050.00
84	90	Small medium	22.50	2,025.00
85	90	do	21.50	1,935.00
86	90	do	22.50	2,025.00
87	90	do	24.00	2,160.00
88	90	do	25.00	2,250.00
89	90	do	24.00	2,160.00
90	90	Small medium; scarred, faulty, etc	19.00	1,710.00
91	90	do	18.50	1,665.00
92	90	do	20.00	1,800.00
93	90	do	18.00	1,620.00
94	90	do	18.50	1,665.00
95	90	do	19.00	1,710.00
96	45	III, medium	11.50	517.50
97	45	do	10.00	450.00
98	45	III, small medium	8.50	382.50
99	45	do	12.50	562.50
	8,298			309,807.00

447 DRESSED, DYED, AND MACHINED PRIBILOF ISLANDS SKINS, DYED LOGWOOD BROWN (BOIS DE CAMPÊCHE)

101	21	Large	$60.00	$1,260.00
102	29	16 large; 13 medium	55.00	1,595.00
103	45	Medium	51.00	2,295.00
104	48	do	46.00	2,208.00
105	40	do	47.50	1,900.00
106	40	do	44.50	1,780.00
107	50	32 medium; 18 small medium	35.00	1,750.00
108	50	Small medium	30.50	1,525.00
109	62	do	28.50	1,767.00
110	29	6 large, 13 medium, 10 small medium; scarred, faulty, etc	$23.00	$667.00
111	33	23 medium, 10 small medium; scarred, faulty, etc	16.50	544.50
	447			17,291.50

Sale of fur-seal skins at St. Louis, Mo., September 24, 1925

200 DRESSED, DYED, AND MACHINED PRIBILOF ISLANDS SKINS, DYED BROWN (DARK CHÂTAIGNE D'OR)

Lot No.	Number of skins	Trade classification	Price per skin	Total for lot	Lot No.	Number of skins	Trade classification	Price per skin	Total for lot
112	29	4 large; 25 medium	$24.00	$696.00	117	28	17 medium, 11 small medium; scarred, faulty, etc	$14.50	$406.00
113	35	7 large; 28 medium	25.00	875.00					
114	40	Medium	23.00	920.00					
115	30	9 medium; 21 small medium	19.00	570.00		200			4,170.00
116	38	Small medium	18.50	703.00					

241 DRESSED, DYED, AND MACHINED PRIBILOF ISLANDS SKINS, DYED BROWN (LIGHT CHÂTAIGNE D'OR)

118	40	3 large; 10 medium; 27 small medium	$20.00	$800.00	124	20	8 medium, 12 small medium; scarred, faulty, etc	$13.00	$260.00
119	20	1 large; 5 medium; 14 small medium	18.50	370.00	125	20	16 medium, 4 small medium; scarred, faulty, etc	12.50	250.00
120	22	14 medium; 8 small medium	19.00	418.00	126	17	14 medium, 3 small medium; scarred, faulty, etc	14.00	238.00
121	47	28 medium; 19 small medium	18.50	869.50					
122	24	13 medium; 11 small medium	16.00	384.00					
123	31	20 medium; 11 small medium	16.50	511.50		241			4,101.00

82 SKINS RECEIVED FROM JAPANESE GOVERNMENT UNDER TREATY PROVISIONS

127	23	Dressed, dyed, and machined, dyed brown (Châtaigne d'Or)	$11.00	$253.00	128	37	Dressed, dyed, and machined, dyed brown (Châtaigne d'Or)	$8.50	$314.50
					130	22	Raw salted; wigs	.50	11.00
						82			578.50

1 CONFISCATED SKIN

Lot No.	Number of skins	Trade classification	Price per skin	Total for lot
129	1	Dressed, dyed, and machined, dyed black	$20.00	$20.00

Special sales of Pribilof sealskins at St. Louis, Mo., in 1925

Date	Number of skins	Description	Price per skin	Total	Date	Number of skins	Description	Price per skin	Total
Jan. 27	10	Dyed black; medium	$38.14	$381.40	June 20	5	Dyed black; medium	$38.14	$190.70
Feb. 21	3	Dyed black; large	44.67	134.01	July 23	7	do	38.14	266.98
Do	16	Dyed black; medium	38.14	610.24	Sept. 10	5	do	38.14	190.70
Do	1	Dyed black; small medium	27.19	27.19	Nov. 11	2	Dyed brown (Bois de Campêche)	45.95	91.90
May 13	30	Dyed brown (Châtaigne d'Or); medium	28.87	866.10	Dec. 9	13	Dyed brown (Bois de Campêche); medium	19.00	247.00
Do	5	Dyed black; large	44.67	223.35	Do	37	Dyed brown (Bois de Campêche); small medium	13.00	481.00
Do	4	Dyed black; medium	38.14	152.56					
Do	1	Dyed black; small medium	27.19	27.19		139			3,890.32

Comparative values, by sizes and grades, with percentages each size, of Pribilof sealskins sold at public auction in 1925

Classes and sales	Grade	Number	High	Low	Average	Total	Total number	Average price	Total price	Percentage
BLACK DYED										
Small wig:										
Sept. 24	I and II	1	$44.00	$44.00	$44.00	$44.00	1	$44.00	$44.00	0.01
Extra extra large:										
May 25	I and II	2	59.00	59.00	59.00	118.00	2	59.00	118.00	.03
Sept. 24	I and II	1	44.00	44.00	44.00	44.00	1	44.00	44.00	.01
Extra large:										
May 25	I and II	26	59.00	59.00	59.00	1,534.00	26	59.00	1,534.00	.45
Sept. 24	I and II	25	58.50	44.00	52.12	1,303.00	33	48.21	1,591.00	.40
	Scarred, faulty, etc.	8	36.00	36.00	36.00	288.00				
Large:										
May 25	I and II	240	46.00	42.00	44.67	10,720.00	406	38.41	15,595.00	6.95
	Scarred, faulty, etc.	160	31.00	29.00	30.00	4,800.00				
	III	6	12.50	12.50	12.50	75.00				
Sept. 24	I and II	567	58.50	42.00	50.32	28,534.00	755	46.27	34,934.00	9.10
	Scarred, faulty, etc.	187	36.00	31.00	34.13	6,382.00				
	III	1	18.00	18.00	18.00	18.00				
Medium:										
May 25	I and II	2,128	40.50	33.00	38.14	81,160.00	3,274	33.92	111,076.00	56.07
	Scarred, faulty, etc.	1,106	27.50	25.00	26.66	29,416.00				
	III	40	12.50	12.50	12.50	500.00				
Sept. 24	I and II	3,128	53.00	37.00	46.32	144,904.00	4,539	40.06	181,814.50	54.70
	Scarred, faulty, etc.	1,310	44.00	16.50	27.28	35,745.00				
	III	101	18.00	10.00	11.54	1,165.50				
Small medium:										
May 25	I and II	1,138	28.00	26.00	27.20	30,951.00	2,131	22.75	48,489.00	36.50
	Scarred, faulty, etc.	900	19.00	17.50	18.35	16,515.00				
	III	93	11.00	11.00	11.00	1,023.00				
Sept. 24	I and II	1,927	41.00	21.50	35.44	68,286.50	2,969	30.78	91,379.50	35.78
	Scarred, faulty, etc.	929	31.00	18.00	23.39	21,734.00				
	III	113	18.00	8.50	12.03	1,359.00				
All classes:										
May 25							5,839	30.28	176,812.00	100.00
Sept. 24							8,298	37.34	309,807.00	100.00
BROWN DYED (CHÂTAIGNE D'OR)										
Extra large:										
May 25	I and II	6	41.00	38.00	40.00	240.00	6	40.00	240.00	.27
Large:										
May 25	I and II	95	45.00	38.00	40.22	3,821.00	144	38.13	5,491.00	6.59
	Scarred, faulty, etc.	49	35.00	32.00	34.08	1,670.00				
Sept. 24	I and II	15	25.00	18.50	23.30	349.50	15	23.30	349.50	3.40
Medium:										
May 25	I and II	705	36.00	25.50	28.87	20,355.50	1,119	24.48	27,389.50	51.19
	Scarred, faulty, etc.	400	20.00	16.00	17.20	6,880.00				
	III	14	11.00	11.00	11.00	154.00				
Sept. 24	I and II	192	25.00	16.00	20.86	4,005.50	247	19.24	4,752.00	56.01
	Scarred, faulty, etc.	55	14.50	12.50	13.57	746.50				
Small medium:										
May 25	I and II	507	22.00	18.50	19.91	10,094.00	917	17.52	16,061.50	41.95
	Scarred, faulty, etc.	403	17.00	14.00	14.62	5,890.50				
	III	7	11.00	11.00	11.00	77.00				
Sept. 24	I and II	149	20.00	16.00	18.54	2,762.00	179	17.71	3,169.50	40.59
	Scarred, faulty, etc.	30	14.50	12.50	13.58	407.50				
All classes:										
May 25							2,186	22.50	49,182.00	100.00
Sept. 24							441	18.76	8,271.00	100.00
BROWN DYED (BOIS DE CAMPÊCHE)										
Large:										
Sept. 24	I and II	37	60.00	55.00	57.84	2,140.00	43	52.98	2,278.00	9.62
	Scarred, faulty, etc.	6	23.00	23.00	23.00	138.00				
Medium:										
Sept. 24	I and II	218	55.00	35.00	45.95	10,018.00	254	42.11	10,696.50	56.82
	Scarred, faulty, etc.	36	23.00	16.50	18.85	678.50				
Small medium:										
Sept. 24	I and II	130	35.00	28.50	30.17	3,922.00	150	28.78	4,317.00	33.56
	Scarred, faulty, etc.	20	23.00	16.50	19.75	395.00				
All classes:										
Sept. 24							447	38.68	17,291.50	100.00

DISPOSITION OF FUR-SEAL SKINS TAKEN AT PRIBILOF ISLANDS

On January 1, 1925, 30,021 fur-seal skins taken at the Pribilof Islands were on hand. Of these, 388 were at the Pribilof Islands, 29,624 at St. Louis, Mo., and 9 at Washington. In 1925, 19,860 skins were secured at the islands and 17,350 were sold, leaving 32,531 on hand on December 31, 1925. The 32,531 Pribilof sealskins on hand on December 31, 1925, comprised 770 at the islands, 31,748 at St. Louis, 11 at Washington, and 2 temporarily shipped to Kansas City, Mo. The following tables show further details in regard to Pribilof sealskins at the islands and at St. Louis, as well as details in regard to other Government-owned sealskins at St. Louis.

Summary of all fur-seal skins handled on Pribilof Islands, calendar year 1925

Island	Balance on hand, Jan. 1	Number taken	Total handled	Number shipped	Balance on hand, Dec. 31
St. Paul	252	15,082	15,334	14,788	546
St. George	136	4,778	4,914	4,690	224
Total	388	19,860	20,248	19,478	770

Summary of Government-owned fur-seal skins in the custody of the Fouke Fur Co., St. Louis, Mo., calendar year 1925

Description	On hand, Jan. 1	Receipts in 1925	Disposed of in 1925	On hand, Dec. 31
Taken on Pribilof Islands:				
Calendar year 1923	12,793	[1] 4	[2] 11,259	1,538
Calendar year 1924	16,831	[3] 388	[4] 6,099	11,120
Calendar year 1925		[3] 19,090		19,090
Skins from Pribilof Islands seals shipped from Steinhart Aquarium	4		[5] 4	
United States' share of Japanese sealskins: Season of 1923	82		[5] 82	
Confiscated skins		9	[5] 2	7
Total	29,710	19,491	17,446	31,755

[1] Shipped from Washington.
[2] 11,254 sold; 5 shipped to Washington.
[3] Shipped from Pribilof Islands.
[4] 6,096 sold; 1 shipped to Washington; 2 shipped to Kansas City, Mo.
[5] Sold.

Corresponding tables in the report for 1924 showed 251 sealskins on St. Paul Island and 16,832 skins of the 1924 take in the custody of the Fouke Fur Co. In 1925 one skin reported shipped in 1924 was found in salt at St. Paul Island.

FOX SKINS

SHIPMENT AND SALE

The 81 blue and 26 white fox skins taken on St. Paul Island in the season of 1924–25, and the 600 blue and 2 white pelts taken on St. George Island in the same season, were placed aboard the U. S. S. *Vega* for shipment in August. These 709 skins were delivered at Bremerton, Wash., on September 1, and were then forwarded by express to St. Louis, Mo.

Of these skins 341 blues and 28 whites were sold at public auction at St. Louis on September 24, 1925. The blue pelts sold for $16,579, an average of $48.62 per skin, the maximum price obtained being $120 per skin for a lot of four. The 28 white pelts sold for $1,040, an average of $37.14 per skin. The average prices received at the last preceding sale (October 15, 1924) of Pribilof Islands fox skins were $63.22 for blue pelts and $42 for white pelts. The remainder of the 1924–25 fox skins will be sold later.

Sale of 341 blue and 28 white fox skins at St. Louis, Mo., September 24, 1925

Lot No.	Number of skins	Trade classification	Price per skin	Total for lot
		BLUE FOX SKINS		
300	4	Extra extra fine	$120.00	$480
301	5	Extra fine	93.00	465
302	5	I dark	79.00	395
303	5	do	75.00	375
304	4	II dark	58.00	232
305	4	Fine	67.00	268
306	8	I pt. II	50.00	400
307	4	Silvery	54.00	216
308	4	Extra extra fine	83.00	332
309	6	Extra fine	60.50	363
310	8	Fine	65.00	520
311	4	Fine dark silvery	89.00	356
312	8	I dark	50.00	400
313	12	II dark	34.00	408
314	14	I dark	55.00	770
315	10	II dark	34.00	340
316	8	I blue	56.00	448
317	10	II blue	33.00	330
318	6	I pt. II dark	51.00	306
319	7	II low	18.00	126
320	8	III and IV	8.00	64
321	4	Extra extra fine	83.00	332
322	6	Extra fine	57.00	342
323	6	Fine	57.00	342
324	10	I dark	55.00	550
325	14	II dark	35.00	490
326	8	I dark	51.00	408
327	10	II dark	35.00	350
328	12	I blue	$40.00	$480
329	10	II blue	31.00	310
330	8	I pt. II	35.00	280
331	4	Extra extra fine	84.00	336
332	4	Extra fine	58.00	232
333	8	Fine	45.00	360
334	10	I dark	51.00	510
335	10	do	46.00	460
336	12	I blue	43.00	516
337	12	II blue	28.00	336
338	7	I dark	42.00	294
339	9	I pt. II	31.00	279
340	5	Silvery	50.00	250
341	4	Extra extra fine	85.00	340
342	12	I dark	54.00	648
343	12	I dark	45.00	540
	341			16,579
		WHITE FOX SKINS		
344	27	I and II pt. stained	37.00	999
345	1	Skin	41.00	41
	28			1,040
	369			17,619

FUR-SEAL PATROL

UNITED STATES COAST GUARD

Five vessels of the United States Coast Guard engaged in the patrol of the North Pacific Ocean and Bering Sea in 1925 for the protection of the fur seals.

The *Snohomish* patrolled the coastal waters from the southern boundary of Washington to Dixon Entrance, southeastern Alaska. The *Unalga* patrolled the coast from Dixon Entrance to Unalaska, and for a time was attached to the Bering Sea patrol force, which was engaged in the patrol of Bering Sea, including the waters about the Aleutian Islands.

The *Algonquin* and the *Haida* were attached to the Bering Sea patrol force throughout the season.

The *Bear* made its annual trip to the Arctic Ocean and took part in the seal patrol while in waters frequented by the herd.

FISHERIES VESSELS

The fisheries patrol boats *Murre* and *Auklet* patrolled waters in southeastern Alaska in the vicinity of Sitka for the protection of the seal herd on its spring migration. The *Murre* assumed the work about the middle of March; the *Auklet*, the latter part of April.

SEALING PRIVILEGES ACCORDED ABORIGINES

In 1925, 2,044 fur-seal skins were authenticated as having been lawfully taken by Indians off the coasts of Washington and Southeast Alaska. The details are as follows:

Washington.—One thousand seven hundred and sixty-five skins were authenticated, of which 823 were from adult male seals, 883 from adult females, 2 adults (sex not specified), and 57 from unborn pups. The skins were authenticated by Dr. Carl B. Boyd, superintendent of the Neah Bay Indian Agency, Neah Bay, Wash.

Southeast Alaska.—Two hundred and seventy-nine skins were authenticated, of which 189 were from adult male seals, 50 from adult females, and 40 from unborn pups.

An official report received by the bureau stated that 4,465 sealskins were taken by the natives of British Columbia in 1925.

JAPANESE SEALSKINS DELIVERED TO THE UNITED STATES

The North Pacific Sealing Convention of July 7, 1911, provides that 10 per cent of the sealskins taken by the Japanese Government within the areas defined by the convention shall be turned over to the United States Government unless the number of seals frequenting the Japanese islands falls below 6,500, enumerated by official count.

At the beginning of the year there was on hand the United States Government's share of sealskins taken by the Japanese Government in 1923, amounting to 82 skins. These skins were sold with others at public auction on September 24, 1925. Details of the sale are given on page 155.

The United States Government's share of sealskins taken by the Japanese Government in 1924 amounted to 94 skins and in 1925 to 87 skins.

FUR SEALS ON ROBBEN ISLAND AND THE COMMANDER ISLANDS

Through the Bureau of Foreign and Domestic Commerce some information has been secured in regard to the Japanese fur seals on Robben Island and the Russian fur seals on the Commander Islands. This information is as follows:

Fur seals on Robben Island

Year	Number of seals in herd	Number of seals killed
1922	19,075	600
1923	23,319	824
1924	28,886	942

Fur seals on Commander Islands

Year	Number of seals in herd	Number of seals killed
1923	12,562	[1]
1924	19,311	[1]

[1] Information not available.

SALE OF CONFISCATED SEA-OTTER SKINS

There were sold at public auction at St. Louis, Mo., on May 25, 1925, for the account of the Government, two sea-otter skins that had been seized by Special Officer Shea from Nick Bruhn at Seward, Alaska, on September 4, 1924. The skins brought $205 and $190, respectively.

FUR-SEAL CENSUS, PRIBILOF ISLANDS, 1925

By Edward C. Johnston

The annual enumeration of the animals composing the fur-seal herd of the Pribilof Islands was made at the height of the season. An actual count was made of the harem and idle bulls on St. Paul Island on July 16 to 18, inclusive, and on St. George Island on July 22 and 23. It was planned to count on St. George Island on July 20 and 21, but transportation was not available until July 21, when the United States fisheries schooner *Eider* carried the enumerator to St. George Island.

In the spring of 1925, before the seals arrived at the islands, all counting towers were inspected and repaired where necessary. The only tower seriously damaged was that on Staraya Artil rookery on St. George Island. Together with the runway, it had been blown down in the previous winter. Rookery numbers were repainted on St. Paul Island, with the exception of a few that could not be located. Most of those not located were situated on the edges of cliffs or caving banks, and probably were destroyed by the action of the sea. The rookery numbers on St. George Island were repainted in 1924.

BULLS

On account of stormy weather during the period when the bulls were counted, it was impossible to reach Sea Lion rock, where Sivutch Rookery is located. It was necessary therefore to estimate the number on that rookery. On all other rookeries of both islands the harem and idle bulls were counted.

In 1923, 5,012 three-year-old male seals were branded with a hot iron. By watching these branded animals, it will be possible to determine when they become harem bulls. In 1924, none was found on the breeding areas, and in 1925 one 5-year-old bull, not branded, was seen holding a cow. Upon discovering the enumerator, however, bull and cow took to the water. Another observer reported having seen two branded 5-year-olds on St. Paul Island, each attempting to hold a cow. Both took to the water shortly after being seen. Taking into account the small number of breeding bulls, it is fairly conclusive that 5-year-olds can not yet be classed as breeding bulls.

In 1924, one bull, estimated to be 6 years old, was seen holding three or four cows. In 1925, seven bulls, probably 6 years old, were found with small harems. Apparently very few 6-year-old bulls can be classed as breeding bulls.

Number of harem and idle bulls, relation of idle bulls to harem bulls, expressed in percentage, and average harem, 1925

Rookery	Date	Harem bulls	Idle bulls	Total	Per cent of harem bulls that equals number of idle bulls	Average harem
St. Paul Island:						
Kitovi	July 17	159	17	176	10.69	47.01
Lukanin	do	84	7	91	8.33	43.03
Gorbatch	do	235	20	255	8.51	80.77
Ardiguen	do	39	1	40	2.56	46.06
Reef	do	507	63	570	12.43	75.20
Sivutch [1]		190	27	217	14.21	61.40
Lagoon	July 17	5	0	5	0.00	30.39
Tolstoi	do	327	28	355	8.56	68.64
Zapadni	July 18	317	23	340	7.26	68.04
Little Zapadni	do	169	13	182	7.69	65.06
Zapadni Reef	do	11	2	13	18.18	34.73
Polovina	July 16	164	24	188	14.63	47.26
Polovina Cliffs	do	99	8	107	8.08	42.87
Little Polovina	do	42	0	42	0.00	36.81
Morjovi	do	80	3	83	3.75	34.74
Vostochni	do	675	47	722	6.96	45.82
Total		3,103	283	3,386	9.12	59.44
St. George Island:						
North	July 23	139	10	149	7.19	108.21
Staraya Artil	do	99	6	105	6.06	114.48
Zapadni	July 22	29	3	32	10.34	55.16
South	do	9	2	11	22.22	41.67
East Reef	July 23	45	4	49	8.89	76.62
East Cliffs	do	102	3	105	2.94	96.48
Total		423	28	451	6.62	98.44
Total (both islands)		3,526	311	3,837	8.82	64.12

[1] Estimated.

The bull count in 1925, as indicated in the above table, showed that there was a large decrease in harem bulls on the rookeries of the northeast side of St. Paul Island. In 1924, Vostochni had 856 harem bulls but in 1925 only 675, a decrease of 181 harems. Virtually all of the rookeries on the south side of St. Paul as well as those of St. George showed an increase in harem bulls. The number of harems on Reef rookery, St. Paul Island, increased from 429 in 1924 to 507 in 1925. North rookery, on St. George Island, increased in size from 127 harems in 1924 to 139 in 1925. On St. Paul Island there were 3,103 harem bulls and on St. George Island 423, a total of 3,526 for both islands. In 1924 the total was 3,516.

The number of idle bulls on both islands decreased from 390 in 1924 to 311 in 1925. The number of idle bulls approximately equaled 11.09 per cent of the number of harem bulls in 1924, and approximately 8.82 per cent in 1925.

Six dead bulls were found. No bulls that had been branded as pups in 1912 were seen on either island.

AVERAGE HAREM

As a pup count was not made in 1925, the average harem was used as the basis for computing the number of cows and pups. A complete pup count was made in 1916 and another in 1922. From the average harems in these two years, an average annual increase in

average harem was determined for each rookery and applied to the average harem in 1924.

Tabulation showing computation of breeding cows

Rookery	Average harem					Harem bulls	Breeding cows
	1916 [1]	1922 [1]	Average annual increase	1924	1925		
St. Paul Island:							
Kitovi	26.00	37.56	1.93	45.08	47.01	159	7,475
Lukanin	33.40	36.92	.59	42.44	43.03	84	3,615
Gorbatch	37.90	64.46	4.43	76.34	80.77	235	18,981
Ardiguen	21.20	41.83	3.44	42.62	46.06	39	1,796
Reef	33.30	59.89	4.43	70.77	75.20	507	38,126
Sivutch	31.00	47.73	2.79	58.61	61.40	190	11,666
Lagoon	29.80	34.13	.72	29.67	30.39	5	152
Tolstoi	33.40	53.42	3.34	65.30	68.64	327	22,445
Zapadni	31.30	52.61	3.55	64.49	68.04	317	21,569
Little Zapadni	35.30	52.34	2.84	62.22	65.06	169	10,995
Zapadni Reef	33.20	29.24	−.66	35.42	34.76	11	382
Polovina	29.30	50.40	3.52	43.74	47.26	164	7,751
Polovina Cliffs	28.50	38.34	1.64	41.23	42.87	99	4,244
Little Polovina	34.60	35.26	.11	36.70	36.81	42	1,546
Morjovi	29.10	38.04	1.49	33.25	34.74	80	2,779
Vostochni	37.30	46.46	1.53	44.29	45.82	675	30,929
Total				55.17	59.44	3,103	184,451
St. George Island:							
North	31.20	78.52	7.89	100.32	108.21	139	15,041
Staraya Artil	39.00	85.01	7.67	106.81	114.48	99	11,334
Zapadni	31.10	42.62	1.92	53.24	55.16	29	1,600
South	6.30	58.00	8.62	33.00	41.62	9	375
East Reef	21.70	48.57	4.48	72.14	76.62	45	3,448
East Cliffs	36.50	68.55	5.34	91.14	96.48	102	9,841
Total				92.21	98.44	423	41,639
Total (both islands)				59.27	64.12	3,526	226,090

[1] Complete pup count made on all rookeries.

As shown by the above table, the average harem for St. Paul Island was computed to be 59.44, an increase of 4.27; for St. George Island the average harem was 98.44, an increase of 6.23.

PUPS AND COWS

As a female seal gives birth to but one pup each year, the number of pups equals the number of cows. In 1925, as in 1923, a pup count was omitted to avoid the great disturbance of rookery life that occurs during the count. The above table shows the method of computing the number of breeding cows and pups. While the numbers computed for the individual rookeries may vary from the numbers actually present, it is believed that the figures for the herd as a whole are fairly accurate. To illustrate: The table below shows an increase in pups on Reef rookery of 25.58 per cent and a decrease on Vostochni rookery of 18.42 per cent. This is due to the increase in the number of harems on Reef and the decrease in the number of harems on Vostochni. It may be that the increase in pups and cows on Reef rookery was not so large nor the decrease so great on Vostochni rookery.

Distribution of pups on the Pribilof Islands, August 10, 1925, compared with distribution in 1924

Rookery	1925				1924	1925	
	Living	Dead	Total	Per cent dead	Total	Increase (+) or decrease (−)	Per cent increase (+) or decrease (−)
St. Paul Island:							
Kitovi	7,365	110	7,475	1.47	6,085	+1,390	+22.84
Lukanin	3,537	78	3,615	2.17	3,480	+135	+3.88
Gorbatch	18,818	163	18,981	.86	16,642	+2,339	+14.05
Ardiguen	1,753	43	1,796	2.39	1,364	+432	+31.67
Reef	37,569	557	38,126	1.46	30,360	+7,766	+25.58
Sivutch	11,381	285	11,666	2.44	10,022	+1,644	+16.40
Lagoon	151	1	152	.37	178	−26	−14.61
Tolstoi	22,133	312	22,445	1.39	20,112	+2,333	+11.60
Zapadni	21,198	371	21,569	1.72	19,153	+2,416	+12.61
Little Zapadni	10,720	275	10,995	2.50	10,080	+915	+9.08
Zapadni Reef	379	3	382	.80	425	−43	−10.12
Polovina	7,632	119	7,751	1.53	7,524	+227	+3.02
Polovina Cliffs	4,165	79	4,244	1.85	4,205	+39	+.93
Little Polovina	1,507	39	1,546	2.51	1,761	−215	−12.21
Morjovi	2,723	56	2,779	2.02	3,225	−446	−13.83
Vostochni	30,286	643	30,929	2.08	37,912	−6,983	−18.42
Total	181,317	3,134	184,451	1.69	172,528	+11,923	+6.91
St. George Island:							
North	14,830	211	15,041	1.40	12,741	+2,300	+18.05
Staraya Artil	11,042	292	11,334	2.58	10,467	+867	+8.28
Zapadni	1,582	18	1,600	1.12	1,544	+56	+3.63
South	369	6	375	1.72	297	+78	+26.26
East Reef	3,396	52	3,448	1.51	2,525	+923	+36.55
East Cliffs	9,694	147	9,841	1.49	8,294	+1,547	+18.65
Total	40,913	726	41,639	1.74	35,868	+5,771	+16.09
Total (both islands)	222,230	3,860	226,090	1.71	208,396	+17,694	+8.49

The above table credits St. Paul Island with 184,451 pups, an increase of 11,923, or 6.91 per cent, over the number in 1924. St. George Island is credited with 41,639 pups, an increase of 5,771, or 16.09 per cent, over the number shown in 1924 census. The total number of pups on both islands was 226,090, an increase of 17,694 or 8.49 per cent.

Exceptionally few dead pups were seen during the bull count. In 1922, also, there was a small number of dead pups. It has been assumed that the percentage of dead in 1925 was the same as that in 1922, which would give a total of 3,860 dead pups, or 1.71 per cent, on both islands.

The number of cows and the number of pups in the herd were identical—226,090. During the bull count no dead cows were found. No cows bearing the 1902 or 1903 brand were seen.

MORTALITY OF SEALS AT SEA

During the last two years, additional information in regard to the loss of seals at sea during their first three years has been secured through branding, and assumed mortality rates have been changed as follows: Males, first year, from 40 per cent to 50 per cent; males, second year, from 17.5 per cent to 25 per cent; males, third year, from 12.5 per cent to 15 per cent; females, first year, from 35 per cent to 45 per cent; females, second year, from 15 per cent to 22.5 per cent.

COMPLETE CENSUS

Following is a summary of the method used to arrive at the complete census for 1925, together with a recapitulation of the herd. It will be noted that the increase in the total number of seals over 1924 was 25,892, or 3.71 per cent. The increase in 1924 over 1923 was 44,150, or 6.76 per cent.

Complete census of fur seals, Pribilof Islands, as of August 10, 1925

Class	St. Paul	St. George	Total
Pups, estimated	184,451	41,639	226,090
Breeding cows, 3 years old and over, by inference	184,451	41,639	226,090
Harem bulls, counted	3,103	423	3,526
Idle bulls, counted	283	28	311
Yearlings, male and female, estimated:			
Females born in 1924	86,264	17,934	104,198
Natural mortality, 45 per cent	38,819	8,070	46,889
Yearling females, Aug. 10, 1925	47,445	9,864	57,309
Males born in 1924	86,264	17,934	104,198
Natural mortality, 50 per cent	43,132	8,967	52,099
Yearling males, beginning 1925	43,132	8,967	52,099
Yearling males killed, 1925	8	----------	8
Yearling males, Aug. 10, 1925	43,124	8,967	52,091
2-year-olds, male and female, estimated:			
Yearling females, Aug. 10, 1924	55,043	9,197	64,240
Natural mortality, 22.5 per cent	12,385	2,069	14,454
2-year-old females, Aug. 10, 1925	42,658	7,128	49,786
Yearling males, Aug. 10, 1924	50,802	8,489	59,291
Yearling males killed, fall, 1924	1	----------	1
Yearling males, end of 1924	50,801	8,489	59,290
Natural mortality, 25 per cent	12,700	2,122	14,822
2-year-olds, beginning 1925	38,101	6,367	44,468
2-year-olds killed, 1925	931	22	953
2-year-old males, Aug. 10, 1925	37,170	6,345	43,515
3-year-old males, estimated:			
2-year-old males, Aug. 10, 1924	39,011	6,674	45,685
2-year-old males killed, fall, 1924	37	8	45
2-year-old males, end of 1924	38,974	6,666	45,640
Natural mortality, 15 per cent	5,846	1,000	6,846
3-year-olds, beginning 1925	33,128	5,666	38,794
3-year-olds killed, 1925	13,126	4,483	17,609
3-year-old males, Aug. 10, 1925	20,002	1,183	21,185
4-year-old males, estimated:			
3-year-old males, Aug. 10, 1924	19,314	2,237	21,551
3-year-old males killed, fall, 1924	201	127	328
3-year-old males, end of 1924	19,113	2,110	21,223
Natural mortality, 10 per cent	1,911	211	2,122
4-year-old males, beginning 1925	17,202	1,899	19,101
4-year-old males killed, 1925	385	24	409
4-year-old males, Aug. 10, 1925	16,817	1,875	18,692
5-year-old males, estimated:			
4-year-old males, Aug. 10, 1924	16,730	1,940	18,670
4-year-old males killed, fall, 1924	10	----------	10
4-year-old males, end of 1924	16,720	1,940	18,660
Natural mortality, 10 per cent	1,672	194	1,866
5-year-old males, beginning 1925	15,048	1,746	16,794
5-year-old males killed, 1925	2	----------	2
5-year-old males, Aug. 10, 1925	15,046	1,746	16,792

Complete census of fur seals, Pribilof Islands, as of August 10, 1925—Continued

Class	St. Paul	St. George	Total
6-year-old males, estimated:			
5-year-old males, Aug. 10, 1924	4,801	331	5,132
5-year-old males killed, fall, 1924			
5-year-old males, end of 1924	4,801	331	5,132
Natural mortality, 20 per cent	960	66	1,026
6-year-old males, beginning 1925	3,841	265	4,106
6-year-old males killed, 1925		1	1
6-year-old males, Aug. 10, 1925	3,841	264	4,105
Surplus bulls, 7 years and over, estimated:			
6-year-old males, Aug. 10, 1924	7,880	609	8,489
6-year-old males killed, fall, 1924			
6-year-old males, end of 1924	7,880	609	8,489
Natural mortality, 20 per cent	1,576	122	1,698
7-year-old males, beginning 1925	6,304	487	6,791
7-year-old males killed, 1925	2		2
7-year-old males, Aug. 10, 1925	6,302	487	6,789
Surplus bulls, Aug. 10, 1924	1,908	135	2,043
Natural mortality, 30 per cent	572	41	613
Remaining surplus for 1925	1,336	94	1,430
Breeding bulls of 1924	3,502	404	3,906
Natural mortality, 30 per cent	1,051	121	1,172
1924 bulls remaining, 1925	2,451	283	2,734
Breeding bulls, 1925	3,386	451	3,837
1924 bulls remaining, deducted	2,451	283	2,734
Increment of new bulls in 1925	935	168	1,103
7-year-old males computed for 1925	6,302	487	6,789
Surplus bulls computed for 1925	1,336	94	1,430
Total theoretical surplus bull stock, 1925	7,638	581	8,219
New increment of breeding bulls deducted	935	168	1,103
Surplus bulls in 1925	6,703	413	7,116
50 per cent deducted for losses due to fighting, natural causes, and errors in loss percentage in previous years	3,351	207	3,558
Surplus bulls, Aug. 10, 1925	3,352	206	3,558
Pups	184,451	41,639	226,090
Cows	184,451	41,639	226,090
Harem bulls	3,103	423	3,526
Idle bulls	283	28	311
Yearling females	47,445	9,864	57,309
Yearling males	43,124	8,967	52,091
2-year-old females	42,658	7,128	49,786
2-year-old males	37,170	6,345	43,515
3-year-old males	20,002	1,183	21,185
4-year-old males	16,817	1,875	18,692
5-year-old males	15,046	1,746	16,792
6-year-old males	3,841	264	4,105
Surplus bulls	3,352	206	3,558
Total, 1925	601,743	121,307	723,050
Total, 1924			697,158
Numerical increase, 1925			25,892
Per cent increase, 1925			3.71

PRELIMINARY REPORT ON THE MARINE FISHERIES OF TEXAS[1]

By Elmer Higgins, *Director*, and Russell Lord, *Junior Aquatic Biologist, Key West (Fla.) Biological Station*

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INTRODUCTION

The idea that it will not be long before the fish supply of Texas and the Atlantic Coast States will be exhausted is fast gaining recognition. The recent scarcity of certain species in the Texas markets emphasized this possibility and brought about a vigorous demand for specific information as to the causes for the shortage and for relief. In response to this demand the Bureau of Fisheries undertook an investigation of the Texas fisheries in order to determine, if possible, the reason for the apparent failure of the supply and whether various species are at present undergoing depletion. The bureau hopes to obtain sufficient information as to the biology of the fish to permit making plans for their protection and for the rehabilitation of the fishery.

Accordingly, in July and August, 1925, the authors conducted a preliminary survey to be used as the basis for future investigations. Various fishing districts, from the Rio Grande to Galveston, were visited, and many fishermen and dealers were interviewed. Dealers' records were consulted and all previous reports on the fisheries were

[1] Appendix IV to the Report of the U. S. Commissioner of Fisheries for 1926. B F Doc. 1009

studied. The results of this survey, which are presented in this report, make it possible to understand better the present condition of the Texas fisheries and to devise plans for more productive work along this line. The following discussion is confined to fish and does not include shrimp and oysters.

SUMMARY

1. The Texas fisheries are largely for shore species taken by seines and gill nets in the sounds and inclosed bays. Redfish, trout, and black drum are the most important species.

2. The imperfect records indicate either a horizontal or a slightly rising trend in the yield of food fish since 1890. The decline in the yield of several valuable species is compensated by the increase in the yield of black drum, which has been considered an inferior fish. A decline in abundance of fish is indicated by the fact that the market supply has not kept pace with the demand.

3. The records are so inadequate that it is impossible to determine the cause of this virtual decline in the fisheries. It is possible that, in addition to natural causes, the stationary condition of the fisheries is caused by excessive legal restrictions.

4. Present knowledge of the habits of the several species is very scanty. The two conflicting opinions are (1) that the fish spawn in the inside bays and (2) that they spawn in the Gulf and come inside only to feed. These problems have not been studied carefully, although such study is necessary for the proper regulation of the fisheries.

5. The many fishery regulations in force are based upon incomplete or defective knowledge, and the men in the industry consider them to be unduly harsh.

6. Recommendations for a program of conservation include the establishment of a system of fishery statistics, the initiation of biological investigations, and the reorganization of the game, fish, and oyster department.

DESCRIPTION OF THE TEXAS FISHERIES

NATURE OF THE COAST

Most of the Texas coast is bordered by a chain of low, sandy islands, which separate the various bays from the Gulf of Mexico. The entire coast line, following the winding shores of the many bays, coves, "lakes," lagoons, and passes, extends about 2,000 miles on the inside and a trifle less than 400 miles on the Gulf side of the bordering islands. The chief bays, from north to south, are Galveston, Matagorda, Espiritu Santo, San Antonio, Mesquite, Aransas, Corpus Christi, and the Laguna Madre. Of these, Galveston, Matagorda, Corpus Christi, and Laguna Madre are the largest.[2] The waters are very shallow, varying from 1 foot or less in depth to 15 or 20 feet in the deeper bays. The bottom varies, also. It is of mud or sand, and in some places is broken by outcrops of rock and

[2] For a complete account of these waters see "Report on the coast fisheries of Texas," by Charles H. Stevenson. *In* Report U. S. Commissioner of Fish and Fisheries, 1889 to 1891 (1893), pp. 373-420. Washington.

by hard oyster reefs. These inside waters are connected with the Gulf of Mexico by the following passes:

1. Galveston Channel, connecting Galveston Bay with the Gulf.
2. San Luis Pass, connecting Galveston West Bay with the Gulf.
3. Pass Cavallo, connecting Matagorda Bay with the Gulf.
4. Cedar Bayou, connecting Mesquite Bay with the Gulf.
5. Aransas Pass, connecting Aransas Bay with the Gulf.
6. Corpus Christi Pass, connecting Corpus Christi Bay with the Gulf.
7. Brazos Santiago Pass, connecting lower Laguna Madre with the Gulf.

The shallow water in these lagoons cools or warms rapidly as the air temperature changes Thus, cold snaps in winter often "numb" great quantities of fish, and an exceptional cold spell with freezing temperature will kill them outright, as happened in December, 1924. High summer temperatures increase the evaporation, and in places where the waters are not sweetened to any great extent by inflow from rivers, the Gulf, or, in periods of drought, from rain, the salinity becomes very great. It has been reported that in Laguna Madre and Baffin Bay quantities of fish succumb every summer to the cumulative effects of an excessive salt content. At periods of flood, however, the inflow of streams is sometimes so great that it is said the water can be used for drinking purposes at the very places where summer evaporation caused the highest salinity. This has been true of Baffin Bay. Despite the great fluctuations in the nature of the water at various times of the year, the bays and lagoons abound with young fish, quantities of mullet (which the piscivorous species prey upon), shrimp, and other food organisms, and therefore are considered to be feeding grounds for great schools of fish that come in through the passes.

Of the passes mentioned, Brazos, Cavallo, and San Luis are reported to be the most favorable for the entrance of fish. These are spoken of by the fishermen as "natural passes" and are distinguished from the "jettied passes," such as the Galveston Channel and Aransas. It is claimed that jetties, especially long ones like those at Galveston, obstruct the movements of the schools along the beaches and cause the fish to mill in the angles of the jetties, thus preventing them from entering the inside fishing grounds. There are natural obstructions, also, such as in Corpus Christi Pass, which, although free from any artificial blockade, has filled gradually until now at low tide the water is only a few inches deep where it flows over the bar. It has been said by Corpus Christi fishermen that whenever the pass was opened by a storm and heavy sea the fishing inside was excellent. The condition of the various passes, then, apparently affects the fishing in the waters immediately adjacent to a marked extent.

METHODS OF FISHING

The Texas fisheries can be classified generally as vessel and shore. The first needs only brief mention, as it is confined largely to boats engaged in fishing with hook and line for red snappers on banks in the Gulf of Mexico. Most of the fish sold in market are caught in the bays and lagoons by the shore fishermen.

Seines.—The name "bay-seine fishery" was applied early to the shore fisheries as descriptive of the method generally employed. All

of the records of the United States Fish Commission, up to and including the year 1902, state that "bay seining" supplied most of the commercial fish. The reason for this is obvious. The shallow water of the fishing grounds always has made it easy for crews to drag and handle seines while standing in water only thigh deep. In fact, the great efficiency of seining has been the chief objection to this mode of fishing in the opinion of those who have thought that the supply of fish in Texas intercoastal waters was being depleted. Finally, in about 1913 a law against summer seining went into effect, and fishermen were forced to buy and use gill and trammel nets. To-day, although this law is no longer in force, more gill and trammel nets than seines are owned and operated along the coast.

Gill nets.—Formerly gill nets were unpopular because the high temperature of the water made it necessary to raise them frequently and remove the catch before the fish spoiled, but the modern method of preserving the catch by packing the fish in cracked ice shortly after they are taken makes possible the saving of gilled fish, which in the past would have spoiled soon after being taken from the nets. The present increased use of gill nets is mentioned in the preceding paragraph, but up to 1902 the reports of the United States Fish Commission did not list a single gill net within the waters of the State of Texas.

Pound nets.—A report of the United States Fish Commission for 1890 states that pound nets were not used on the Texas coast because the large fish, such as gars, tarpon, jewfish, and sharks, or predatory animals like the porpoise, tore the netting so frequently that more time was spent in repairing the nets than in fishing. Recently, a fisherman tested a pound net in the Gulf of Mexico, but the piles were pulled up and the nets broken, whether by tides or large animals the experimenter could not say. Another attempt will be made with wire mesh.

Miscellaneous methods.—Besides net fishing, there is a certain amount of line fishing, cast netting, and spearing of flounders. "Gigging" for flounders, as it is called, is carried on extensively at certain seasons of the year, and the catch is disposed of locally.

COMMERCIAL SPECIES

The chief commercial species of Texas fish are as follows:

Bluefish	*Pomatomus saltatrix.*
Croaker	*Micropogon undulatus.*
Drum	*Pogonias cromis.*
Flounder	*Paralichthys lethostigma*, and others.
Grouper	Epinephelus sp.
Jackfish	*Caranx hippos.*
Jewfish	*Epinephelus nigratus.*
Mackerel	*Scomberomorus maculatus.*
Mullet	*Mugil cephalus.*
Pigfish	*Orthopristis chrysopterus.*
Pompano	*Trachynotus carolinus.*
Redfish	*Sciaenops ocellatus.*
Red snapper	Lutjanus sp.
Rockfish	*Roccus lineatus.*
Sand trout	*Cynoscion nothus.*
Sheepshead	*Archosargus probatocephalus.*
Trout	*Cynoscion nebulosus*
Whiting	Menticirrhus sp.

While the tastes of the trade run chiefly to trout, redfish, and mackerel, quantities of so-called "inferior" species (black drum especially) are now being caught and shipped.[3] The Gulf "pike" (*Centropomus undecimalis*) is sometimes abundant around the passes farther south and also is very popular with the market. According to information received, the sheepshead, once very abundant, never has been appreciated by the public, and the mullet, so prized in the southeastern section of the country, is not fished for commercially at all, although it literally swarms in all of the shallow bays along the coast.

HISTORY OF THE FISHERIES

The present status of the Texas fisheries can be understood best in the light of their past development. However, the records of the fisheries are exceedingly meager. The only sources of information concerning the yield in past years are publications of the Bureau of Fisheries and of the Bureau of the Census and the State commissioners' reports.

Records of the Texas fisheries have appeared in various reports of the Bureau of Fisheries since 1880. They have been collected by systematic surveys conducted at considerable intervals by special agents sent into the field to interview personally dealers and fishermen throughout the geographic section canvassed; for example, the Gulf States. The most important surveys were conducted in 1880, 1890, 1902, 1918, and 1923.

The occasional nature of such canvasses limits the usefulness of the records in studying depletion, for it is obvious that if statistics are made available only at intervals of several years there is relatively slight possibility that a normal year was selected in which to make a canvass of the fisheries. Hence, the fluctuations in yield, as shown by the records, may not represent fairly the general trend of the fisheries unless the trend is well marked and a long period of time is considered. Furthermore, the method by which the records necessarily are collected makes it impossible to secure complete information in all cases, for the data consist of dealers' and fishermen's records or their estimates of the preceding year's catch. The uniformity of the methods of collection, however, makes the figures comparable, and we believe that the statistics given here are of real significance.

The statistics for 1908 were collected by the Bureau of the Census, which used a form virtually identical with that employed by the Bureau of Fisheries. However, there was a larger number of canvassers in the field than took part in previous surveys, and it is probably because of this that the 1908 record is not always strictly comparable with the records of the Bureau of Fisheries.

The records of total fish yield obtained from the Texas Game, Fish, and Oyster Commission are compiled from tax receipts published in the annual reports of the department. Commercial fish caught in Texas intercoastal waters are subject to a tax of 20 cents per 100 pounds. The catches are reported monthly from daily records supposed to be kept by the fishermen, and payment is made to the deputy commissioners or to the central office at Austin. Hence, the amount of tax collected depends upon the honesty of the fishermen

[3] See Statistical Bulletin No. 670, U. S. Bureau of Fisheries, for further details.

or the efficiency and industry of the fishery deputies. The resulting records therefore are subject to wide fluctuations in the various fishery administrations and must be given broad interpretation when determining the changing yield of the fisheries. In State records the

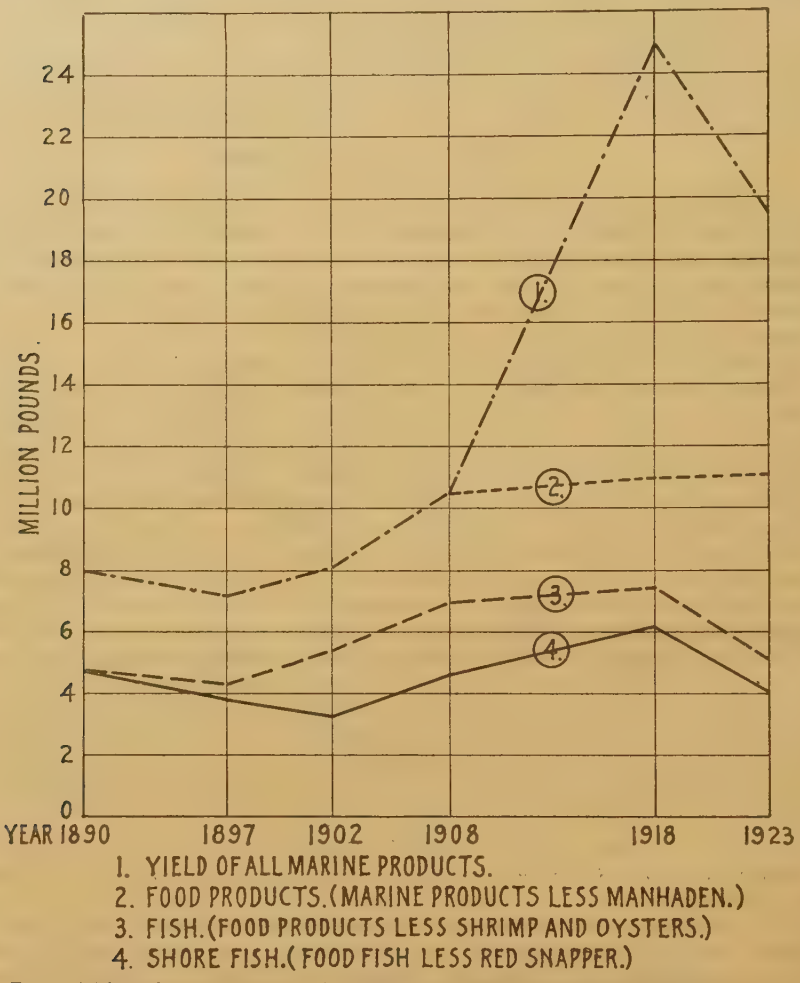

FIG. 1.—Yield of the Texas fisheries. (Data from the Bureau of Fisheries and the Bureau of the Census)

figures representing the total catch include only the actual catch of the shore fisheries, minus oysters, shrimp, crabs, and other marine products.

TOTAL YIELD

An examination of the Bureau of Fisheries' reports for the State of Texas shows an enormous increase in the total yield of all fishery products since the first survey, in 1880. From a total yield of less than 4,000,000 pounds the quantity more than doubled in the succeeding 10 years. During the 20 years following the total yield

fluctuated but little; but beginning in 1908 an enormous increase is shown, which reached a maximum of more than 25,000,000 pounds in the war year of 1918, followed by a drop of about 5,000,000 pounds in 1923. This increase of 150 per cent since 1908 was due almost entirely to the development of the menhaden industry. In 1918 over 14,000,000 pounds, or 56 per cent, of the total catch of fish consisted of menhaden. The actual rise in yield of all marine food products in the 33 years since 1890 has been only about 39 per cent.

Table 1 shows the yield, in round thousands of pounds, in the years in which Government surveys were made. The first column gives the total yield of all marine products and shows the remarkable rise in quantity. The second column gives the total yield of all marine food products except menhaden. Menhaden are used in the manufacture of oil and fish scrap and therefore were subtracted from the grand total. Thus the high figures of 1918 and 1923 are reduced to a less impressive level. The third column shows the quantities of food fish produced, excluding menhaden, shrimp, and oysters. The oyster catch has been almost constant, between 2,500,000 and 3,500,000 pounds annually; but the shrimp catch jumped from a level that had remained at from 200,000 to 300,000 pounds annually until 1918, to the surprising quantity of 3,500,000 pounds in 1923. The fourth column is the most significant of all for our purpose of judging the condition of the fishery. It represents the yield of the shore fishery only, for menhaden, shrimp, oysters, and red snapper (which are caught far offshore in the Gulf) are excluded. These figures show the almost horizontal trend of the yield except for the high war-time figure in 1918. The shore fisheries, excluding those for oysters and shrimp, apparently have neither increased nor decreased materially in yield during the 33-year period since 1890. All of these data are presented graphically in Figure 1.

TABLE 1.—*Yield of the Texas fisheries*

[Data from the Bureau of Fisheries and from the Bureau of the Census]

Year	All marine products	Food products [1]	Fish [2]	Fish [3]
	Pounds	*Pounds*	*Pounds*	*Pounds*
1880	3,859,000			
1890	7,959,000	7,959,000	4,698,000	4,693,000
1897	7,175,000	7,175,000	4,323,000	3,858,000
1902	8,044,000	8,044,000	5,351,000	3,283,000
1908	10,439,000	10,439,000	6,893,000	4,641,000
1918	25,015,000	10,896,000	7,390,000	6,147,000
1923	19,560,000	11,043,000	5,102,000	4,093,000

[1] Not including menhaden.
[2] All food products except shrimp and oysters.
[3] All food fish except red snapper.

However, this fact alone hardly can be used as an argument to show that the shore fisheries have been depleted, for there is little evidence of the vigor with which or extent to which these fisheries have been prosecuted. Table 2, which shows the number of persons engaged in the fisheries, the number of vessels, and the investment, serves this purpose imperfectly. Actually, the exploitation of the

shore fisheries may have diminished, which, rather than overfishing, might account for the failing yield.

TABLE 2.—*Number of persons engaged, number of boats and vessels, and total investment in the Texas fisheries*

[Data from the Bureau of Fisheries and from the Bureau of the Census]

Year	Number of persons	Number of boats and vessels	Total value of investment	Year	Number of persons	Number of boats and vessels	Total value of investment
1890	1,277	847	$315,427	1908	1,780	1,148	$445,000
1897	1,199	731	237,496	1918	1,886	1,025	890,100
1902	1,144	623	373,724	1923	1,399	811	567,114

A study of the State records from 1901 to 1924, inclusive, in contrast with those of the Bureau of Fisheries, shows a general upward trend of the fisheries throughout that period. From 1901 to 1904, inclusive, there was a sharp increase in the number of pounds of fish caught each year. From 1906 to 1915, inclusive, the catch remained at about the same level. Of course, various minor fluctuations took place, but on the whole the level remained constant. During the war (1916 to 1918, inclusive) a great increase in the total tonnage occurred, followed by a drop in 1919 and 1920. In 1921 there was a sharp recovery, which continued to improve until the maximum yield (exclusive of the forced fishing during the war) was reached in 1924.

TABLE 3.—*Yield of the Texas shore fisheries (omitting menhaden, red snapper, shrimp, and oysters*

[Data taken from Texas State reports]

Year	Pounds	Year	Pounds	Year	Pounds
1901	2,715,168	1909	3,262,840	1917	6,057,987
1902	2,899,000	1910	3,872,750	1918	4,963,874
1903	3,350,555	1911	3,672,750	1919	4,046,301
1904	4,187,354	1912	3,612,267	1920	3,591,460
1905	(1)	1913	2,473,604	1921	4,162,192
1906	2,451,581	1914	3,205,576	1922	[2] 5,162,008
1907	2,282,506	1915	3,698,057	1923	4,460,071
1908	3,184,947	1916	5,618,103	1924	4,913,369

[1] Not available.

[2] A shrimp fishery was started in the winter of 1922, and great quantities were taken with otter trawls. The big 1922 catch was listed with the fish and accounts for the sudden increase in quantity of products. Prior to 1922 small quantities of shrimp were included, but from 1923 on they were listed separately, 1,239,305 pounds having been taken in 1923 and 1,792,284 pounds in 1924.

VARIATIONS IN YIELD OF THE SHORE FISHERIES AT VARIOUS FISHING CENTERS

The statistics of the yield of the various fishing centers are very faulty because of the lack of a uniform system of recording tax returns. The only places where reasonably reliable records were kept were Galveston, Matagorda, Port Lavaca, Rockport, Corpus Christi, and Point Isabel. These records are illustrated graphically in Figure 2.

TABLE 4.—*Amounts of fish landed at various fishing centers on the Texas coast, in pounds*

[Taken from Texas State reports]

Year	Galveston	Matagorda	Port Lavaca	Rockport	Corpus Christi	Point Isabel
1901	438,000	18,000	751,000	680,000	438,818	36,000
1903*	647,000	125,000	775,000	805,000	475,200	185,000
1904	547,000	250,000	768,000	1,120,000	857,000	180,000
1906*	217,000	237,349	443,075	903,904	553,490	373,374
1907	185,119	257,665	307,975	711,042	713,608	666,630
1908	202,235	243,226	476,934	715,896	569,611	710,290
1910*	238,400	367,038	467,830	916,410	996,579	446,110
1912*	240,320	255,807	430,756	625,334	930,578	800,566
1914*	247,569	242,618	124,845	515,124	915,907	528,145
1915	237,155	199,536	157,272	566,895	861,367	803,199
1919*	178,622	170,385	26,102	219,436	621,937	1,398,885
1920	115,928	222,101	251,335	545,070	314,656	989,195
1923*	137,583	180,785	600,895	1,423,752	629,819	634,882
1924	267,407	158,919	818,542	906,448	1,042,155	1,158,623

*Indicates a break in the continuity of the table.

NOTE.—Figures for the years previous to 1923 include small quantities of shrimp.

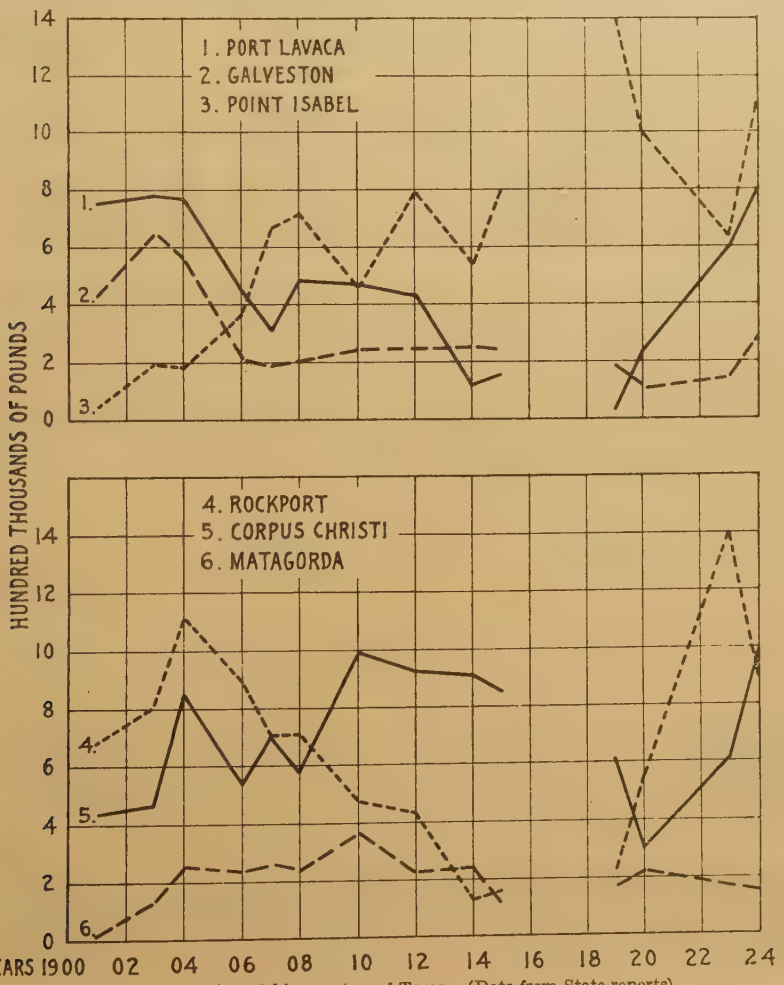
1. PORT LAVACA
2. GALVESTON
3. POINT ISABEL
4. ROCKPORT
5. CORPUS CHRISTI
6. MATAGORDA
HUNDRED THOUSANDS OF POUNDS
YEARS 1900 02 04 06 08 10 12 14 16 18 20 22 24

FIG. 2.—Yield of the various fishing centers of Texas. (Data from State reports)

It is unfortunate that the statistics for these fishing centers are not complete, but in the main they justify the following observations:

At Galveston the catch for the years 1901 to 1904, inclusive, showed a general upward trend. There was a sudden drop in 1906, and the catch stayed at this general level until 1924, when a slight increase was noted.

At Matagorda the catch for the years 1901 to 1904, inclusive, showed a decided upward trend, and the following years, as at Galveston, showed a catch that remained fairly constant until 1924.

At Port Lavaca the catch for the years 1901 to 1904, inclusive, remained at an almost constant high level. There was a sudden sharp drop in 1906, followed by a general downward tendency, which persisted until 1919. In 1920 the catch suddenly increased, and it continued to increase until 1924, when the high record of the 1901–1904 period was reached and passed.

At Rockport the catch for the years 1901 to 1904, inclusive, showed a steady upward trend. This was followed by a sudden drop in 1906, and a downward tendency prevailed until 1919. A very great rise occurred in 1923, and while the catch for 1924 was much better than for many years previous it was not as high as that of 1923.

At Corpus Christi the years 1901 to 1904, inclusive, showed a distinct yearly increase. This was followed in 1906 by a sudden drop, and from then until the high point was reached in 1910 the general trend was upward. Then came a slow decline, that in the years 1919 and 1920 dropped still lower. The years 1923 and 1924 showed a great increase in the catch, which reached its maximum in the latter year.

At Point Isabel the years 1901 to 1904, inclusive, showed a general increase in the annual catch, and from then on the trend was steadily upward until 1919. A falling off occurred in 1920 and 1923, but the catch returned to almost its previous maximum in 1924.

The production of each of these fishing centers may be shown by dividing the 13 years for which we have statistics into two periods. According to the greatest mean annual production, the ranks for the two periods are as follows:

TABLE 5

Port	1901 to 1910		1912 to 1924	
	Average annual production	Rank	Average annual production	Rank
	Pounds		*Pounds*	
Rockport	836,036	1	700,294	3
Corpus Christi	657,758	2	759,634	2
Port Lavaca	569,930	3	344,249	4
Point Isabel	371,057	4	901,927	1
Galveston	353,536	5	203,512	6
Matagorda	214,039	6	204,307	5

The most notable differences in the two periods are the rise of Point Isabel from fourth to first place and the decline of Galveston from fifth to sixth.

Obviously it is impossible, because of the paucity of data, to explain the difference in yield in the various localities, even if it be taken for granted that the available statistics truthfully represent the catches of fish. Various explanations have been offered, but none of these were based upon reliable observations. For instance, it has been suggested that the decline of the fisheries of Galveston is attributable to oil pollution, the building of rock jetties at the harbor entrance, and the general development of commercial traffic. Likewise, the development of the fisheries at Point Isabel has been attributed to the isolated situation and the relatively unspoiled natural conditions on the fishing grounds. These, of course, are plausible explanations, but their truth or falsity should be determined.

INFLUENCE OF LEGAL RESTRICTIONS ON THE CATCH

There may be other explanations for the rise and fall of the catch along the coast. For example, it has been argued that the enforcement of the various State fishery regulations has greatly influenced the amount of fish caught. While it is recognized that the size of the annual catch is affected by diverse conflicting influences, the following is offered as a possible influencing factor:

1901–1904.—The catch in these years increased annually or held fairly constant in each locality. This represents the normal progress of fisheries unaffected by any serious legal restrictions.

1905–1913.—The catch in these years dropped suddenly in 1906 at all localities except Point Isabel. From 1906 until 1913 the catches at all points except Corpus Christi and Point Isabel maintained a level trend or else showed a downward tendency. Only the two ports named showed a general increase.

The sudden drop in 1906 might very well have been due to the passage of laws that suddenly closed as spawning grounds a great deal of water. No net fishing was allowed in certain bays, coves, and bayous. At Point Isabel alone no waters were set aside as spawning grounds, and this was the only port that showed an increased catch in 1906. Corpus Christi was affected only temporarily, as the water closed there never produced any appreciable part of the total catch. On the whole, however, it is significant that closing the waters as a breeding grounds suddenly stopped the yearly increase in every fishing center but one, and in most cases kept production below what would have been normal if the fisheries had been allowed to operate unrestricted.

1914 and 1915.—In 1914 another sudden drop in the catch of all the fishing centers took place. Point Isabel also was affected. In 1915 none but this southernmost fishery succeeded in equaling the record of 1912.

This second drop, which affected all fisheries alike, no doubt was attributable to a new law that prohibited seining of any kind during the summer months. (It is said, however, that gill and set nets were dragged whenever the fishermen had an opportunity to do so unobserved. Also, the fishermen worked in closed waters whenever possible.)

1916–1918.—During the period of the war all State restrictions were abated by Federal advice and all waters were thrown open to

nearly every sort of fishing. The individual records for each fishing center are lacking, but the figures for the State as a whole show a great increase over the years preceding and following.

1919–1922.—In 1919 a sudden and general drop took place throughout the entire fishing section, with the exception of Point Isabel. Beginning in February, all of the pre-war regulations were reinstated, breeding grounds were designated and closed to netting, and summer seining was once more forbidden. Law enforcement at Point Isabel was not very strict until the summer of 1922, but in September of

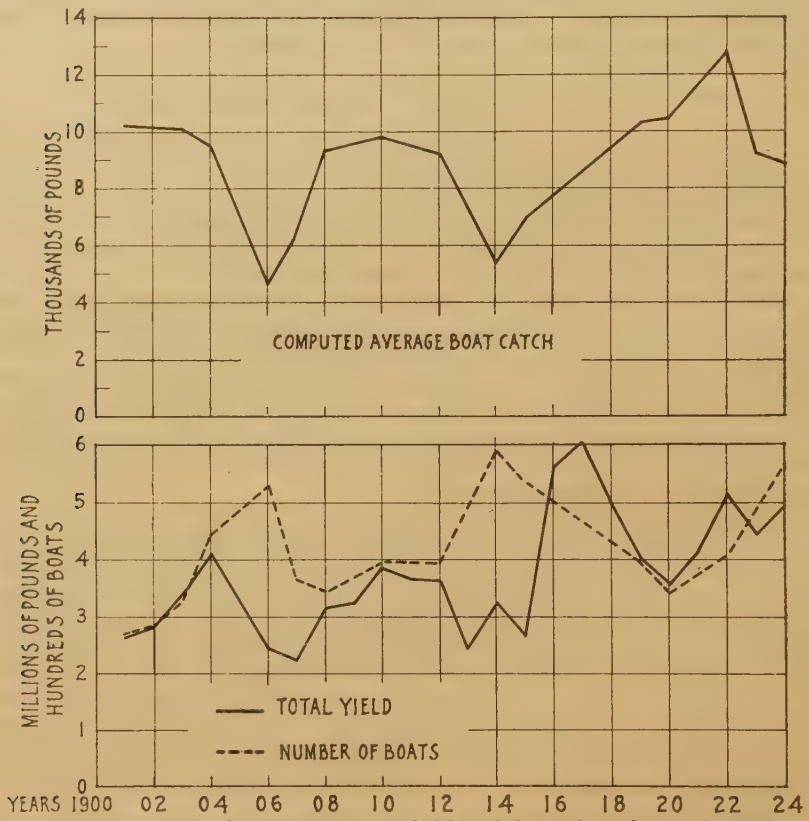
THOUSANDS OF POUNDS
COMPUTED AVERAGE BOAT CATCH
MILLIONS OF POUNDS AND HUNDREDS OF BOATS
TOTAL YIELD
NUMBER OF BOATS
YEARS 1900 02 04 06 08 10 12 14 16 18 20 22 24

FIG. 3.—Average boat catch, computed from total yield and the number of boats. (Data taken from Texas State reports)

that year the laws against summer seining were repealed. (For a discussion of law enforcement at Point Isabel, see p. 194 of this report.)

1923 and 1924.—While the laws closing certain waters as breeding grounds for fish were still in force, summer seining was permitted.

In these years a general tendency toward an increased catch was indicated, although the catch at Point Isabel was subnormal. The year 1924 showed an increase over 1923 in every locality except Rockport and Matagorda. However, the 1923 catch at Rockport was the greatest recorded for a single fishery in any year. Thus, a direct connection between restrictive legislation and the yield of the fisheries is strongly indicated.

A comparison of the total yield of the State with the number of boats engaged in fishing further emphasizes the effect of restrictive measures on the catch. Although the number of boats in operation in 1906 was greater than in any of the four preceding years, the total quantity of fish taken from Texas intercoastal waters was 1,500,000 pounds less than in 1904, the year with the largest catch. Prior to 1906 the parallel between the amount of fish caught and the number of boats in use was distinct. This same parallel continued to exist after the restrictions of 1906 were in force, until 1913 and 1914, when further restrictions caused the catch to fall off greatly, although the number of boats in use was greater in 1914 than in any previous year. From 1919 on there was again a very close parallel between the annual catch and the number of fishing boats in use. The average catch per boat followed the same general trend, of course. (See fig. 3.)

TABLE 6.—*Yield of the Texas fisheries from 1901 to 1924 and average annual boat catch as computed from total yield and number of boats*

[Data taken from Texas State reports]

Year	Pounds	Number of boats	Average catch, in thousands of pounds	Year	Pounds	Number of boats	Average catch, in thousands of pounds
1901	2,715,000	265	10.2	1914	3,206,000	592	5.4
1902	2,899,000	----------	----------	1915	3,698,000	538	6.9
1903	3,350,000	333	10.1	1916	5,618,000	----------	----------
1904	4,187,000	441	9.5	1917	6,058,000	----------	----------
1906	2,452,000	531	4.6	1918	4,964,000	----------	----------
1907	2,283,000	363	6.3	1919	4,046,000	394	10.3
1908	3,185,000	344	9.3	1920	3,591,000	343	10.5
1909	3,263,000	----------	----------	1921	4,162,000	----------	----------
1910	3,873,000	396	9.8	1922	5,162,000	402	12.8
1911	3,673,000	----------	----------	1923	4,460,000	483	9.2
1912	3,612,000	391	9.2	1924	4,913,000	565	8.7
1913	2,474,000	----------	----------				

Thus, we see that whenever rigorous restrictions are put into effect the total catch, as well as the average catch per fishing boat, falls off.

YIELD OF THE VARIOUS FISHERIES

Additional light may be thrown upon the state of the fisheries by studying the variations in the yield of the several species. Here again we are confronted by the same unfortunate lack of adequate records. The tax reports of the State commission list only the total tax on "fish" and do not name the species. The surveys of the Bureau of Fisheries are more complete, however, and from them we must gain all of our knowledge as to the courses of the various fisheries. The yield of the chief fisheries in the various years in which surveys were made is given, by species, in Table 7, and is illustrated graphically in Figure 4.

TABLE 7.—*Yield, in pounds, of the chief species taken in the Texas fisheries*

Species	1890	1897	1902	1908 [1]	1918	1923
Red snapper	4,800	464,791	2,067,987	2,252,000	1,243,002	1,008,960
Redfish	1,107,950	1,144,376	898,450	928,000	1,336,535	877,760
Trout	1,120,450	1,011,620	1,119,300	1,055,000	1,613,370	1,523,965
Sheepshead	778,800	467,504	217,330	298,000	197,662	140,610
Flounders	130,650	218,025	240,900	140,000	162,361	118,395
Spanish mackerel	25,000	40,710	63,830	42,000	41,354	78,920
Whiting			41,700	9,900	35,970	11,400
Catfish	45,000	71,330	75,000	560,000	262,000	50,340
Croaker	175,950	136,700	58,050	159,000	197,560	67,970
Black drum		50,400	157,400	381,000	1,873,440	1,028,450
Grouper		3,460	40,170		20,840	32,730
Jewfish	47,000	33,280	65,720	46,000	39,970	13,450
Mullet	55,950	60,850	18,800	20,000	53,275	7,540

[1] Figures taken from report of the Bureau of the Census; all others from the U. S. Bureau of Fisheries' reports.

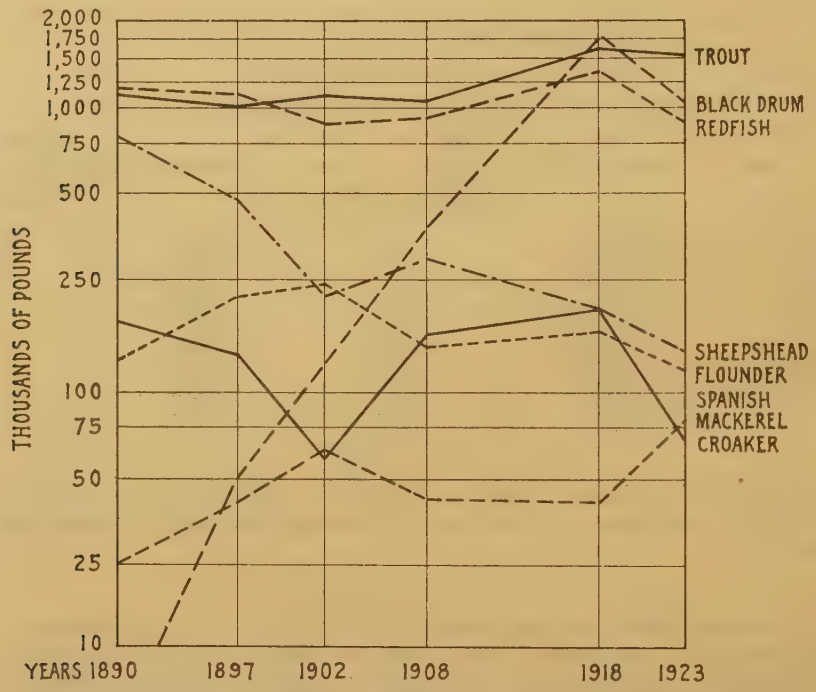

FIG. 4.—Yield of the Texas fisheries, by species. (Data from the Bureau of Fisheries and the Bureau of the Census.) Figures shown on a logarithmic scale to show relative rather than absolute changes. This has the effect of reducing the figures for each year to a percentage of the previous year's record. The slope of the lines, therefore, indicates the rate of increase or decrease in the yields of the various species

Outstanding features of the Texas fisheries are the great concentration on two or three species of fish, particularly redfish and trout; the remarkable rise and subsequent decline of the red-snapper fishery; the equally remarkable rise in the yield of the black-drum fishery; and the horizontal trend of all other fisheries except that for sheepshead.

Redfish and trout have formed about half of the total take of all food fish in Texas since the earliest survey. The yield of both of these species has been relatively constant, fluctuating about half a million pounds during the period 1890 to 1923. The trend for both

species has been virtually horizontal, also, although since 1908 the catch of trout has increased somewhat more than that of redfish. Both are valuable species, the redfish yielding the fishermen 8.2 cents per pound and the trout 10.1 cents in 1923.

From 1897 to 1902 the yield of the more important species in the shore fisheries declined somewhat, but this decline was more than compensated by a remarkable development in the offshore fishery for red snapper. The quantity taken of this valuable fish increased about 400 per cent in this period, reaching a total of over 2,000,000 pounds, and continued to increase another 250,000 pounds in the next six years. From 1908, however, the catch fell, until in 1923 the total was about 1,000,000 pounds.

The fishery for the black drum has experienced an increase in yield almost as spectacular as that of the red snapper. The black drum is one of the cheaper, less popular fish and in earlier times was discarded when taken in the fishermen's hauls. The first yield of any importance was recorded in 1902, but from that time on the rise was rapid, reaching a peak of almost 2,000,000 pounds during the war year of 1918 and exceeding all other species. Although the fishery declined greatly in 1923, it was exceeded only by trout and amounted to well over 1,000,000 pounds.

Among the minor fisheries the sheepshead shows the greatest variation in yield. From 1890 to 1902 the decline was marked, and although a slight increase took place in 1908 the general decline continued, reaching the lowest point in 1923.

The relative importance of each species in the annual catches is shown in Table 8. Here may be seen the rise and fall of the red-snapper fishery and the rise in popularity of the black drum until it constituted one-fourth or one-third of the total catch of all food fish.

TABLE 8.—*Per cent of the various species of fishes in the total yield of food fish in Texas in various years*

[Data taken from reports of the Bureau of Fisheries and the Bureau of the Census]

Species	1890	1897	1902	1908	1918	1923	Average price per pound in 1923
More valuable species:							*Cents*
Red snapper	0.1	11.0	38.6	32.7	16.8	19.6	8.0
Redfish	23.5	26.5	16.8	13.5	18.1	17.2	8.2
Trout	23.9	23.4	20.9	15.2	21.8	29.8	10.1
Sheepshead	16.6	10.8	4.1	4.3	2.7	2.7	5.8
Flounders	2.8	5.0	4.5	2.0	2.2	2.3	8.6
Spanish mackerel	.5	.9	1.2	.6	.6	1.5	10.4
Whiting	-------	-------	.8	.1	.5	.2	8.9
Total	67.4	77.6	86.9	68.4	62.7	73.3	[1] 8.6
Less valuable species:							
Catfish	1.0	1.6	1.4	8.1	3.5	1.0	5.2
Croaker	3.7	3.2	1.1	2.3	2.7	1.3	4.8
Black drum	-------	1.2	2.9	5.5	25.4	20.2	3.6
Grouper	-------	.1	.7	-------	.3	.6	3.0
Jewfish	1.0	.8	1.2	.7	.5	.3	4.1
Mullet	1.2	1.4	.3	.3	.7	.1	3.3
Total	6.9	8.3	7.6	16.9	33.1	23.5	[1] 4.0
All others	25.7	14.1	5.5	14.7	4.2	3.2	-------
Grand total	100.0	100.0	100.0	100.0	100.0	100.0	-------

[1] Average.

SIGNIFICANCE OF FLUCTUATIONS IN YIELD

As has been stated before, the object of this inquiry is to discover, if possible, whether or not the fisheries of Texas are suffering from depletion by overfishing. Depletion of a fishery usually is understood to mean a decreasing yield in relation to the effort involved; and although no single adequate test for depletion has been developed, the various lines of evidence by which the condition may be recognized have been summarized admirably by W. F. Thompson.[4] It is conceded generally by fishery investigators that the amount per boat of the commercial catch is a reliable index to the relative abundance of the stock of fish in the sea. A progressive decline in the average catch per boat thus would indicate a decline in abundance; but this can be determined only by an examination of records collected in such a manner as to show the catches of each boat day by day and calls for extensive fishery statistics. Moreover, a decline in abundance may be brought about by natural causes outside of human control and must be distinguished from overfishing. Biological studies may be depended upon to aid in distinguishing between the possible natural and artificial causes of depletion. Changes in the method of fishing and in the locality of the fishing grounds, as well as such economic factors as demand, market competition, distribution, etc., also must be be considered when studying the records of the yield.

The available records of past development of the Texas fisheries are inadequate to demonstrate whether depletion is going on. Both State and Government statistics are not only contradictory to a degree and unreliable as to fact, but are in such form that they are useless for determining the relative abundance of the fish supply. The trend of the total yield of the shore fisheries, as shown by the Federal records, has been almost horizontal for the 33-year period since 1890, but the records of the State show a rise in the yield.

Despite the possible slight increase in the total yield, it is evident that the supply has not kept pace with the demand. The population and hence the potential demand, has increased at a greater rate than has the production of food fish.[5] To meet the local demand, the supply has been augmented by shipments of fish from the eastern Gulf States and from California. From this fact alone one might conclude that the fisheries had reached their fullest development and were on the decline because of overexploitation, were it not for the complicating factor of legal restrictions, which undoubtedly operate to reduce the annual yield.

In the older fisheries, where depletion of the more desirable species is taking place, the market is being supplied with increasing quantities of the smaller and less desirable species. An example of such a shifting from the better to the cheaper classes of fish, characteristic of a declining fishery, is found in the larger catches of black drum. (See Table 8.) The yield of six species of cheaper fish that average 4 cents per pound rose from 6.9 per cent of the total yield of all food fish in 1890 to 33.1 per cent in 1918, and still amounted to 23.5 per

[4] In "California Fish and Game," vol. 8, July, 1922, p. 172.

[5] The population of Texas in 1920 was 100.8 per cent greater than in 1890, while the yield of food fish in 1923 was only 6.5 per cent greater than in 1890, as shown by the records of the Bureau of the Census and the Bureau of Fisheries. The population of Texas in 1890 was 2,235,527; 3,048,710 in 1900; 3,896,542 in 1910; and 4,663,228 in 1920.

cent of the total yield in 1923. Thus it may be seen that during the war, when the demand was greatest and the fewest restrictions were imposed upon fishing, the yield of the poorer fishes reached its maximum. That black drum was marketed at all is unmistakable evidence of an inadequate supply of the more desirable species—snapper, trout, and redfish.

The probable causes of the reduced productiveness may be natural or artificial. Among the natural causes may be mentioned the various physiographic and meteorological features of the coast. Shallow, inclosed waters, subject to extremes of heat and cold that periodically destroy or greatly reduce various species; the shifting and closing of passages to inside waters; the drouths, accompanied by increased salinity; and the floods that bring great quantities of silt from the rivers; all have their effect in limiting the abundance of fish life in the inside waters.[6]

Perhaps the most far-reaching artificial limitations upon the yield of the fisheries are the legal restrictions. There is no clear evidence to prove that these restrictions are necessary or unnecessary, beneficial or harmful. As pointed out in a previous section, when laws that prohibit summer seining and close certain waters to fishing are put into effect the total catch is greatly reduced. It is true that subsequent to the establishment of such closure the yield tends to increase and approach previous normal production, but this recovery may be explained in several ways. It is possible that such increase may be due to an actual increase in the fish stock brought about by the protection. It is also possible that the fishermen, driven from accustomed fishing grounds one year, succeed in following years in finding other grounds equally productive. Again, it is possible that poaching in the closed areas and during closed seasons increases, as the laws become older and more familiar. In any event, although it is evident that the laws are effective, it yet remains to be shown whether they are wise, beneficial, and necessary or arbitrary, harsh, and unduly restrictive.

Another limitation upon the yield of the fisheries, and one without apparent justification, is that imposed by crude and wasteful methods of handling and marketing. While scarcely within the scope of this inquiry, we can not refrain from mentioning that improvements in refrigeration, in icing, and in preserving the catch will bring about an extension of the industry without attendant drain upon the fish supply.

There is no way to determine the capacity of a fishery except by actual trial by commercial fishing, hence it is impossible to predict the future development of the Texas shore fisheries should they be allowed to develop unhindered by restrictions.

CURRENT IDEAS AS TO THE BIOLOGY OF THE VARIOUS SPECIES

Before a fishery can be regulated scientifically the life histories of all the important commercial species must be studied thoroughly. Very little is known of the habits of Texas fishes, although a great many guesses have been made. Breeding habits, especially, have

[6] A considerable mortality among food fishes is said to occur annually in Laguna Madre and connecting waters. This mortality apparently occurs regularly during the months of August and September, supposedly in consequence of the extreme saltiness of the water, and during January because of the cold. Observations are now being conducted in Laguna Madre to determine the condition of the water throughout the year and to ascertain, if possible, just what conditions are destructive of fish life. A report on this subject will be prepared when the study has been completed.

been a matter for contention for many years. The following extracts from State reports will give some idea as to the opinions generally held. In 1908 State Commissioner R. H. Wood's report contained this:

> From the east end of Galveston Bay to the Rio Grande we have what might justly be called one long natural breeding ground for fish; a series of shoal bays, protected by outlying islands, which form a barrier to the storms of the Gulf, with bottoms covered by grasses to which fish are sent by nature when in roe.

Several years later, another commissioner, W. G. Sterret, in a report for 1914, said:

> My opinion is, and it is based on the personal observations of those who for years engaged in taking fish for market, that nearly all of our commercial fish, or fish caught for market, breed in the Gulf. For in late summer they are found—redfish, trout, mullet, and even flounders—going to the Gulf when full of eggs. If this be true, or only partly true, the importance of keeping open the ways is apparent.

Such are the two general theories with regard to the spawning habits of Texas fish.

The fish, game, and oyster commission of Texas has endeavored to benefit the fisheries by enforcing regulations based upon popular ideas as to the breeding habits of the species. Before the fish and oyster laws of 1925 went into effect Chief Deputy Harry W. Wells wrote letters to various fish dealers along the Texas coast, asking their opinion as to the breeding habits of the fish in their localities. The concensus of opinion was that very few of the inside coves and bays were known to be spawning grounds. An extract from a reply, under date of February 29, 1924, will illustrate the opinion held at Corpus Christi.

> We think, rather, that the great majority of the fish come in from the Gulf, and the amount that spawns and grows in the bays here amounts to an inconsiderable quantity. We have noticed throughout the years when the passes have been opened there has always been a sufficient quantity of fish in the bays, and whenever at any time the passes have filled up or have become shallow it is always at that time that fish become scarce.

The writer of this did say, however, that the black drum spawned in Oso Bay, appearing in February and leaving about the middle of April. These were big, 20-pound fish and were found in the bay at no other time of year. This, together with the fact that no small fish ever were taken in the larger bodies of water such as Nueces Bay and the Laguna Madre, led to the opinion that whatever fish did seek the inside waters as spawning grounds, frequented small, sheltered bodies of water such as the Oso and Ingleside Cove.

Another letter from the Corpus Christi section states that if the passes were to be closed tightly and fishing continued no fish but mullet and catfish would be left in the inside waters. This writer says that he used a very small-meshed seine in a great many places in Laguna Madre but could not find the young fish he was looking for. Then he changed his location to the Gulf shore of Padre Island, and, using his words, "at each and every haul netted thousands of miniature redfish, trout, croakers, sheepshead, and even pompano entangled in the seaweed." From this experiment he concluded that the fish spawned outside, and that as soon as the young were able they worked through the passes into the shallow inside waters, where they could feed and find shelter in the long grass.

A Corpus Christi dealer, when interviewed, declared that the shallow, hot, salty water of Laguna Madre and tributary bays was not pleasing to the native instincts of the fish, but that they would spawn inside if they had to. "Some of these fish may deposit their spawn inside because they can not get out," he said. This was due to blocked passes or low water. He thought that the schools of redfish, drum, and trout were working always toward the Gulf when taken with spawn in a nearly ripe condition.

Nearly every fisherman interviewed, from Galveston to Brownsville, believed that young fish come in from the Gulf after attaining a certain size. One man reported seeing great schools of tiny redfish, just large enough to be identified by the characteristic black spot on the caudal fin, working into the inside waters through various passes along the coast. In the summer of 1922 G. F. Simmonds, a biologist of the State university, investigated the coastal waters in an effort to discover some exact facts as to the breeding habits of the commercial species. Extracts from his notes are given later in this section.

HABITS OF THE SPECIES

Redfish (*Sciænops ocellatus*)

The idea that the redfish spawns outside the barrier islands in the Gulf of Mexico is firmly established now. It is well known that no roe is to be found in this species until a weight of 8 or 9 pounds has been attained, and such fish are then known as the "bull reds," or spawners. The exact location of the spawning grounds has not been described. The redfish, when not in schools on the outside in the breeding season, live in considerable numbers in the inside waters, feeding on the flats and moving in and out, when possible, with the tides. In regard to the redfish, Mr. Simmonds writes (from notes on file in the State commissioner's office at Austin):

> Though careful investigation has been made, not a single young redfish has been found in Texas intercoastal salt waters in summer, the smallest fish seined in even the most favorable localities being 10 inches long; fully adult redfish rarely weigh less than 12 pounds, although occasionally a 9-pound fish, and once one of 6 pounds, may be found with mature reproductive organs; fish with well-developed roe have been caught along the Texas coast in winter; and it seems probable that this species spawns at that season in the middle surf of the Gulf and just outside the passes leading in to the feeding grounds. The spawning habits of the redfish should be more adequately studied in order to pass adequate protection.

Louis Cobolini, of Brownsville, who has been in the fishing business for a great many years, has taken records of the fluctuating seasonal abundance of various species. At Point Isabel great schools of redfish with ripe or nearly ripe roe are found in the Gulf near Brazos Santiago Pass during February, March, April, and May. He reports that in the old days, before the present law prohibiting the taking of "bull reds" went into effect, the fishermen used to lie idle, with anchored boats, waiting sometimes two or three days before the big schools of spawning redfish appeared along the coast. Spent redfish begin to work into the Laguna Madre in the greatest quantities in August.

Such is the extent of the knowledge regarding the redfish in Texas. Information from other sources is just as meager, making the life history of the species an important matter for investigation, not only in Texas but throughout the range of the fish.

Spotted Trout (*Cynoscion nebulosus*)

The habits of the spotted trout are not as well agreed upon as those of the redfish. In order to secure as much information as possible regarding the habits of this species, various fishermen and dealers all along the coast were questioned. Mr. Cobolini reports that at Point Isabel the trout are most abundant in winter; that is, during December, January, February, and March many more of them are caught than at any other period. Toward the latter part of February, however, the catch begins to fall off as the trout leave. Mr. Cobolini especially emphasized the highly migratory nature of the species and how quickly temperature influences its abundance in local waters. Cold weather sends these fish to deep water, where they remain until the waters of the lagoon warm again.

Table 9, copied by Mr. Cobolini from a fisherman's book, shows the effect of an unusually cold spell on the abundance of trout near Point Isabel during December, 1924. The amounts of fish recorded were all landed by the same crews.

Table 9.—*Weather Bureau reports, Brownsville, Tex., and catch of spotted trout, December, 1924*

Date	Air temperature, ° F. Maximum	Minimum	Mean	Number of pounds taken	Date	Air temperature, ° F. Maximum	Minimum	Mean	Number of pounds taken
1	78	64	71		19	74	31	52	
2	77	67	72		20	32	27	30	
3	79	65	72		21	33	26	30	
4	80	64	72		22	43	31	37	
5	81	61	71		23	67	38	52	
6	83	73	78		24	63	36	50	
7	82	74	78		25	36	28	32	535
8	78	61	70		26	47	33	40	
9	69	57	63		27	47	39	43	
10	61	44	52	25,000	28	51	38	44	
11	52	43	48		29	48	38	43	
12	69	47	58		30	67	45	56	
13	64	56	60		31	71	44	58	10,300
14	75	58	66						
15	79	65	72						
16	79	70	74						
17	79	71	75						
18	80	72	76						

From the 1st to the 18th, inclusive, with an average mean temperature for the period of 68°, the daily catch of trout averaged 1,400 pounds. From the 19th to the 30th, inclusive, the catch for the entire period was only 535 pounds, an average of 45 pounds per day. The average mean air temperature for this period was 42° F. Although the unusual cold weather might easily have kept the boats from fishing as intensively as usual, Mr. Cobolini reports that the crews went out every day but returned with hardly any trout. This continued until the daily mean temperature again reached 58°, and on that day the catch amounted to 10,000 pounds. The trout were supposed to be working again in great numbers from the Gulf into the shallower waters of the Laguna Madre. If the trout had not had free access to the Gulf of Mexico through Brazos Pass they would have perished from the cold, as did the thousands upon

thousands of pounds of mullet that were caught farther up the lagoon where the water is very shallow.

Although they are not strictly pelagic fish like the mackerel, the trout, as well as other species caught by the Texas fishermen, are more abundant on some days than on others. The fishermen agree that there is a general movement of the fish—trout, redfish, and others—northward at the approach of summer and southward at the approach of winter; but the comparative abundance of the various species changes from day to day. An extract from a report of the United States Fish Commission for the years 1889 to 1891 (p. 379) is as follows:

> Occasionally the fish taken by a crew during several days consist almost entirely of one of these three most plentiful species. On several occasions the writer has at different ports in Texas seen several thousand pounds of fish of which probably 90 per cent were of the same species. One week they may be nearly all sheepshead and the next week trout or redfish.

This is mentioned to show that the appearance of great numbers of fish does not necessarily mean that they are schooling preparatory to spawning.

Very few people, however, agree as to the spawning habits of the spotted trout. Never in all his fishing experience has Mr. Cobolini seen ripe roe in any of the trout he has examined. It is well to compare this information with reports from various fishing centers farther north. At Matagorda, when the trout first appear in the early spring and fall they contain no roe. The roe seems to develop during the summer and fall, and just at the time when trout should be taken with roe fully ripe they disappear; as one man expressed it, "Just before spawning not a trout can be found." Galveston fishermen report that they have taken trout with immature roe during April and May, but none with ripe roe. When asked whether they could tell anything concerning the breeding habits of the species they were unable to say. They believed, however, that the trout spawned outside in the Gulf, like the redfish. Mr. Simmonds, writing for the Galveston Daily News, Saturday, October 1, 1921, said:

> Trout are even more mysterious in their habits than the redfish. They are caught in the bays at certain times when full of eggs, and at other times they are caught in the bays when they appear to have just laid their eggs. But many trout, mullet, and flounders have been caught going to the Gulf when full of eggs. Therefore, the passes are protected against seining, even though it is supposed the trout breed in the bays and inlets.

During the summer of 1922 Mr. Simmonds himself investigated coastal waters in an effort to learn something definite as to the breeding habits of commercial fish. The following is quoted from some of his notes on file in the State commissioner's office at Austin.

> The spotted trout deposits its eggs on good bottom, among growing turtle grass or widgeon grass (*Ruppia maratima*), generally in well-protected bays, back bays, and sounds. The most important spawning grounds along the Texas coast are Ingleside Cove on the north side of Corpus Christi Bay, Aransas Bay just in front of the town of Aransas Pass, Kellers Bay, Turtle Bay, and the southwest corner of West Galveston Bay. Adequate protection should be given the fish in these small protected bays during the height of the spawning season which comes twice a year on the Texas coast, in early May and early September, though individual fish may be found spawning from early spring well into fall or even occasionally during mild winters. The egg is smaller than that of the Atlantic trout or speckled squeteague, measuring about one thirty-second of an inch, and in waters of 77° hatches in 40 hours. After hatching, the small fry are usually most abundant in loose, rather unorganized schools in floating sea-

weed and among thick bottom-grass or widgeon-grass growths, where young grass shrimp, together with silverside and killifish minnows, are abundant; particularly where grasses and seaweeds are so thick as to make dragging a seine almost impossible. In addition to the food just named, the young fry and fingerlings feed on lesser amounts of any other moving foods found on the feeding grounds. They eat an enormous amount of food and grow very rapidly, reaching a length of over an inch in less than a month, and for several months thereafter practically doubling their length each month. A 2-inch fish, after a month of good feeding, will measure 4½ inches, and still another month later will measure 7 inches. Under best possible conditions of life, such as are found in many places along the Texas coast, many individuals reach marketable size in about seven months.

The habits of the spotted trout in other parts of its range are hardly better understood than in Texas, although similar habits of this species are reported from other localities. Dr. Hugh M. Smith, in "The Fishes of North Carolina," gives some notes written by Yarrow for the years 1871 and 1872, on observations taken at Beaufort, N. C. Yarrow says:

Very abundant from February to June, April being considered the best month; are taken at this time in nets only, as they will not take the hook until September, upon their return from the northward. The roe in female specimens was found to be quite large in April.

Spotted trout, as well as gray trout, are reported to spawn in North Carolina waters during the late spring and early summer, according to Doctor Smith. He says also that the spawning grounds of the spotted trout are the well-protected bays and sounds.

Spanish Mackerel (*Scomberomorus maculatus*)

Although the Spanish mackerel is not a coast fish, but a pelagic species, it is mentioned here because it is one of the most popular fishes with the trade. The fishermen on the Texas coast have not concerned themselves with its habits, nor have any conservationists worried about its scarcity or abundance. When the mackerel runs occur, the fishermen employ hand troll lines and gill nets near the passes and reap the harvest while they can. The general habits of the mackerel apparently are fairly well understood. Along the Atlantic coast there is said to be a general movement of the schools northward in the spring and back again in fall. Off the coast of North Carolina it is hard to find any mackerel after November. Again referring to "The Fishes of North Carolina," we find the following:

The fish doubtless spawns throughout its range on the United States coast, but, as shown hereafter, apparently very few remain on the North Carolina coast during the spawning season. The lower part of Chesapeake Bay was and still is a favorite spawning ground. The eggs are about 1 millimeter (0.04 inch) in diameter and float at the surface; they are laid mostly at night, and the hatching period is about 25 hours in a water temperature of 77° or 78° F. All the eggs of a given fish do not ripen at one time, and the spawning may thus extend over several weeks, during which several hundred thousand eggs may be deposited.

Doctor Smith says also that on the Atlantic coast the females of the northward-bound schools had a roe that was yet immature, but on the return run not a fish contained roe and all were in fine condition, being very fat and about a pound heavier on an average than on the run north. The exact movements of such pelagic creatures as mackerel are hard to determine, of course, but the Texas fishermen are not alarmed about the mackerel supply, as the mackerel is not deemed

a resident fish. Trolling in the Gulf near Aransas Pass is sometimes very successful, and hundreds of pounds of mackerel often are caught by a single fisherman in one day.

Black Drum (*Pogonias cromis*)

The black drum is now more popular in the Texas market, but prior to 1889 there is no record of its being handled. The adult drum are large, coarse fish, which are sometimes hosts to parasitic worms. Small or "baby" drum averaging 4 or 5 pounds in weight are now in demand. These young drum are excellent eating and quite the equal or even the superior of the redfish. On the whole, however, the drum has not been esteemed either by the trade or the fishermen. It is most abundant in Texas waters, and according to Mr. Cobolini it can be caught at Point Isabel any day in the year.

The oyster-eating habits of the big drum have been widely advertised, as these fish often are very destructive to beds of planted oysters. It is reported that bunch oysters, with their sharp cutting edges, are relatively well protected from the depredations of the drum, but planted oysters, especially young, thin-shelled ones that have been well culled, are easily taken up and crushed by the strong pharyngeals.

The spawning habits of this species have not been studied carefully. An extract from the notes of Mr. Simmonds on this subject reads as follows:

> Practically nothing is known about the breeding habits of the fish. Young fish, ranging from those scarcely over a month and a half old to those nearly grown, were found in shallows of Laguna Madre near Point Isabel, in Oso Creek back from Corpus Christi Bay, and in scattered localities along intercoastal waters as far east as Galveston Bay, particularly at Mitchell's Cut and about the head of Matagorda Bay.

An observer at Corpus Christi has named Oso Bay as one positive spawning ground for black drum. The most interesting feature of the black-drum fishery in Texas is the way in which it has increased, rising from almost nothing in 1889 to second place in 1923.

Sheepshead (*Archosargus probatocephalus*)

The sheepshead formerly was one of the three most abundant species caught for market. This species long has been one of the most prized of table fish, as its flesh has a particularly pleasing quality and flavor. Recently, however, it has seemed to be very scarce on the Texas coast. One fish dealer, writing from Matagorda in February, 1924, says "They disappeared, went west, in droves of millions and have never been plentiful since. They were not caught out; no market for them * * *; they left here * * *; why or where they went no one seems to know." This observer states that several years ago sheepshead were so thick in the neighborhood of Matagorda that they could not be given away, much less sold.

Extracts from Mr. Simmonds's notes on the spawning habits of this species are as follows:

> The sheepshead spawns usually during March and early April, at which time the females in schools swim in about sundown to a depth of 6 or 8 feet on sandy Gulf beaches along the coast, where males feed during the day. The small transparent eggs, measuring about one thirty-second inch, have a specific gravity less than that of sea water, on which they have a tendency to float. In the warmer waters of the Gulf of Mexico, at about 76° F., they hatch in 40 hours.

On the habits of the sheepshead in other localities, we find this:

At the spawning season, which is in the spring, the sheepshead swim in schools and appear to prefer sandy shores. The eggs are about 0.03 inch in diameter, and more than 1,500,000 are in a liquid quart. They float at the surface and hatch rapidly, only 40 hours being required in water of 76° or 77° F.[7]

NATURE OF PRESENT KNOWLEDGE AND THE NEED FOR FUTURE WORK

Popular and local ideas as to the habits of fish often are so contradictory and so varied that at best they serve only to indicate the facts that need real investigation. Hence, some of the information just given, although containing interesting observations and perhaps a great deal of truth, falls far short of the plain facts that must be the basis for future regulation of the fishery.

There has been very little scientific research specifically relating to the biology and habits of the commercial fishes of Texas other than Mr. Simmonds's brief investigation, which is mentioned in the foregoing section. A report of the United States Fish Commission (see p. 168 of this paper) contains a few references to the habitat and spawning weight of a few of the commercial species, but these are so brief as scarcely to be considered scientific investigations of Texas fish. Mr. Simmonds, on the other hand, evidently found a wealth of material during his one short summer in the field; but a few months' work, no matter how intensive, is not sufficient to collect all the information necessary for a complete understanding of even a single species. While an investigation of this nature no doubt contributes somewhat to our total knowledge, much further research is necessary before we can arrive at such definite conclusions.

Most of the study of the species of fish found in Texas waters has been carried on along the Atlantic coast. The excellent paper by Dr. Hugh M. Smith [8] sums up the known facts concerning the Atlantic coast species prior to 1907, and thus indirectly throws light on some of the Texas species.

One of the most recent publications that also indirectly concerns Texas fish is a paper on the Sciænidæ by Welsh and Breder.[9] This paper summarizes all that has been written on the life histories of the Sciænidæ prior to 1923. It also contains original notes based on field work. The authors further point out the incompleteness of our knowledge concerning the family Sciænidæ, which includes the spotted trout, redfish, black drum, and other less important commercial fishes of Texas. To quote from their introduction:

In this paper an effort has been made to bring together such facts as have been recorded concerning the life histories of the family Sciænidæ found on the Atlantic coast of the United States. The matter contained in it is fragmentary and the blank places in our knowledge of the subject are many and large. As yet there has been no systematic attempt on the part of investigators to study the life histories of this economically important group of fishes, and such facts as have been brought to light form a very imperfect patchwork, which may well be compared to a picture puzzle in which most of the parts are still missing.

It is quite evident that adequate investigations of the fisheries must be made before any suitable means of regulating and controlling

[7] Dr. Hugh M. Smith, in "The Fishes of North Carolina."

[8] "The Fishes of North Carolina," by Hugh M. Smith. North Carolina Geological and Economic Survey, Vol. II, 1917. Raleigh, N. C.

[9] "Contributions to life histories of Sciænidæ of the eastern United States coast," by William W. Welsh and C. M. Breder, jr. Bulletin, United States Bureau of Fisheries, Vol. XXXIX, 1923-24 (1924), pp. 141-201, figs. 1-60. Washington.

them can be adopted. A scientific investigation of the Texas fisheries must include elaborate and extended studies of the various phases of the life histories of all the important commercial species. This is a work requiring not months, but years. All popular ideas must be tested, all previous research of a scientific nature must be verified, and then original data, full and complete, must be secured regarding the biology and ecology of trout, redfish, drum, sheepshead, and other species. The local distribution and the fluctuating seasonal abundance of these species in the waters of the State must be determined as well as the reason for such distribution and such seasonal abundance. In short, most intensive research in the field of fishery investigations should be carried on and mature conclusions reached before drastic regulations are enacted.

CONSERVATION OF THE TEXAS FISHERIES

TRUE AIM OF CONSERVATION

The term "conservation" has been greatly abused and often has become associated in the minds of various people, particularly the commercial fishermen throughout the country, with oppressive restrictions upon their activities. It is appropriate, therefore, to restate the true meaning of the term. Conservation implies the fullest and wisest use of nature's wealth without endangering the supply for the future. Applied to fisheries, it includes all efforts toward producing at present and maintaining for all time the maximum yield. Thus, the efforts of any class, either sportsmen or commercial interests, to unduly restrict or to overexploit are both selfish and unpatriotic and contrary to the purposes of conservation.

PAST ATTEMPTS AT CONSERVATION

The State of Texas long has been aware that the fisheries, like any great natural resource, are subject to depletion if exploitation is too intensive. Hence, the object of various fish and oyster laws has been the protection, conservation, and increase of all valuable forms of marine life. The game, fish, and oyster commission has been successful in enforcing laws that have had for their purpose the protection and conservation of both fresh and salt water species of fish, but the increasing of the natural supply has been a problem of a different nature. While the artificial propagation of fresh-water forms, such as the large-mouthed black bass and rainbow trout, has met with success, no definite means of increasing the supply of marine fish has been developed as yet. The efficiency of the fresh-water hatcheries, as well as those for various anadromous fishes, particularly the salmon, has caused the people to believe that fish culture will be the future means for increasing the supply of valuable marine fish. Thus, from time to time the idea of a salt-water fish hatchery has been brought up and seriously considered.

ARTIFICIAL PROPAGATION

State Commissioner R. H. Wood believed that the only way to increase the fish supply on the Texas coast is for the State to operate a hatchery. Following is an extract from his report for 1907:

> We own many necks of water where the redfish, trout, and sheepshead go to spawn. At one or more of these places there could be located, at little expense

to the State, a hatchery which in season could turn out millions of these fish. Our State should produce sufficient fish not only for our own people but should supply the citizens of Oklahoma, Indian Territory, Kansas, Colorado, and other States west of the Mississippi River.

In his next two reports (1908 and 1909) Mr. Wood still emphasized the need of building a hatchery in order to increase the fish supply. In 1910 he again suggested that two hatcheries for the propagation of marine fish would, without the slightest doubt, operate to multiply, many times over, the output of fish within, he says, "a couple of years." In short, Mr. Wood had the greatest faith in the phenomenal powers of fish hatcheries.

Commissioner W. G. Sterett, in his report for 1912, suggested that Federal investigation be made regarding the propagation of fish and oysters. When he was again commissioner in 1919, he wrote as follows:

> For years we have heard of the establishment of a salt-water fish hatchery on our coast. Fortunately, none of these have materialized. I say this because I do not believe they would have answered the purpose of filling our bays with fish.

Mr. Sterett then goes on to say that because of the great extent and irregularity of the coast line a stationary hatchery could not benefit the whole State, and instead strongly recommends "an artificial fish hatchery on a boat, which will go from one end of our salt-water line to the other, hatching and distributing fish as it goes."

At the present time (1925) there is some talk and newspaper propaganda concerning the building of a hatchery for marine fish. This is due to the general belief in the depletion of the fisheries and is but the voicing of the popular demand for conservation and development. Investigators in Europe [10] have conducted a more critical examination of the hatching of marine fishes than has ever been made in this country, and the results of their observations throw strong doubt upon the practical utility of attempting to increase the supply of strictly marine commercial fish by means of hatcheries. It is not likely, therefore, that any attempts in that direction will be made until adequate scientific investigation has proved the need and the feasibility of artificial propagation of marine fishes in Texas.

FISHERY REGULATIONS

The game, fish, and oyster commission of Texas has endeavored to protect and increase the supply of fish in the intercoastal waters by enforcing laws of varied nature:

1. Laws to regulate the kind and length of the nets used, the size of the mesh, and to require that all nets be licensed.
2. Laws to protect breeding fish by closing against net fishing certain bays, bayous, lagoons, and "lakes" that are to be known as spawning grounds.
3. Laws to protect breeding fish and young fish by prohibiting the use of seines during June, July, and August.
4. Laws to prevent the taking of "bull reds," or the spawning redfish.

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[10] "The Problem of Sea Fish Hatching," by Knut Dahl. Conseil Permanent International pour l'Exploration de la Mer, Rapports et Procès-Verbaux, Vol. X, No. 5, 39 pp., 13 text figs., 1909. Copenhague.

5. Laws to stop the taking and sale of fish under certain size limits.

6. Laws to assure the fish entrance to the inside waters by prohibiting fishing with nets in any of the passes leading from the Gulf of Mexico or from one body of coastal water to another.

A brief summary of the history of the laws just mentioned follows. One of the first records that mention the conservation of Texas fishes is found in a report of the United States Fish Commission for 1890, on page 380:

> Believing that the fish are caught in greater quantities than their natural fecundity can make good, there is a desire on the part of many persons, especially those interested in developing the sporting fisheries of Texas, to restrict in some way the use of seines. While the supply of fish may be decreasing, yet there does not appear to be an urgent necessity for a very great restriction. The cessation of the seine fishery in the bays for four months, from May to August, which is the plan generally urged, would throw entirely out of employment over 350 men, removing from the coast towns a monthly revenue of more than $12,000 and taking from the market a cheap and wholesome article of food. It would also seriously affect the marketing of fish taken during the winter, since purchasers in the interior would prefer obtaining their supplies from such sources as could provide for them continuously throughout the year. If restriction be deemed expedient and necessary, the prevention of marketing of large fish, say of redfish weighing over 14 pounds (advocates of a close time contend that redfish, more than any other species, require special protection), would largely answer the purpose without embarrassing persons depending on the bay seine fishery for a living. These large redfish are the spawning fish. They are difficult to market, being coarse and of poor flavor, and are sometimes even thrown away.

Such a law was finally enacted, and at the present time it is illegal to catch or handle "bull redfish" (for commercial purposes) over 32 inches long entire, or, without the head, over 27 inches from the gill cavity to the tip of the tail. In 1924 the first strict enforcement of this law made dealers and fishermen regard it, and at the present time the regulation is well accepted. Thus, the spawning redfish has protection, as was suggested as early as 1890.

I. P. Kibbe, State commissioner of Texas, in his report for 1904 lists the laws made during his term of office that define and close certain bays and bayous as breeding grounds for fish. This included a great deal of water from one end of the coast line to the other, and usually those waters known to the fishermen as the best places in which to find fish. Thus, by giving them ample space in which to deposit their spawn unmolested, it was sought to increase the supply of fish in the coastal waters of the State. From about September, 1913, in addition to this law, a restriction against the use of seines during June, July, and August was put into effect; but during the period of the World War all these laws were disregarded and wide-open fishing was allowed at any time, any place, and with almost any sort of gear. This was done with Federal approval.

Such a condition prevailed from 1916 until February, 1919. At that time all the old, pre-war restrictions went into effect again; breeding grounds were protected, size limits on certain species were strictly enforced, all nets had to come under definite specifications, and no seining at all was allowed during the summer months. It was hard, however, for the Mexican fishermen to understand why such good fishing should suddenly be denied them; why they should have to fish 1 mile from the passes instead of only 500 yards away, as during the war. Consequently, they made it a practice to fish in closed waters and to drag gill and trammel nets whenever they had an oppor-

tunity to do so unobserved, despite the efforts of the State deputies to enforce the law. During the summer of 1922 a biologist from the State university conducted a survey of the coastal waters, studying the spawning habits of the commercial species. His reports were instrumental in the abolishing by the thirty-eighth legislature of the law prohibiting summer seining, as the redfish, which the law was primarily designed to protect, showed no indication of spawning in inside waters. All other laws, however, remained in force.

It is interesting to note that there was a return to the old question first written of in 1890. To quote W. W. Boyd, commissioner, in his report for the fiscal year ended August 31, 1924, "The belief among sport fishermen that commercial fishing is depleting the supply of fish on the Texas coast is not borne out by the records of this office. The production of this year surpasses that of the preceding year by 172,724 pounds." Mr. Boyd, however, does recommend that the next legislature reinstate the closed season on summer seining. He goes even farther, saying that all nets of any kind should be kept out of the waters during the summer months, and as his reason offers a popular theory that the long grass, which shelters small fish and food organisms, reaches maturity in the summer months, and that the lead lines of the seines break off this grass, which becomes entangled in the meshes of the net and prevents the small fish from going through. He says also that the stinging jellyfish are abundant during the summer, and when they come in contact with a fish's gills the fish is quickly killed by the poison. Mr. Boyd writes: "The enormous waste of fish life in our coastal waters during the summer months is hard to estimate." The next legislature, however, did not close waters to summer seining, as recommended by this commissioner, but the laws protecting the passes and "breeding areas" were strictly enforced.

Effects of fishery regulations.—The reaction to fishery legislation of those engaged in the fish business of Texas can be summed up in one word—dissatisfaction. To quote W. W. Boyd, State commissioner, in his 1922 report, "The fish and oyster laws are very unpopular with the fishing fraternity along the coast, and we have incurred enmity because our deputies insist on the law being observed and burn the seines found in closed waters, as directed by law." In the same report Mr. Boyd stated: "The fishermen at Point Isabel, finding out that we were in earnest in enforcing the law, decided to observe the closed season on drag seines, and not having any of the strike or trammel nets practically no fishing was done during June, July, and August. As an evidence of this the tax receipts for August, 1921, totaled $240.34 and for the same month this year $6.69."

It is easy to see why the fishermen would resent the law, when it struck directly at their personal property and welfare; but their personal resentment toward the fish and oyster laws is only a part of the widespread discontent.

J. R. Jefferson, commissioner, in his report for 1920, in speaking of the lack of true scientific knowledge as regards the habits of fish and the protective measures that should be based on such knowledge, says:

> About the only protection we offer them is to prohibit the use of seines during the summer months and the sale of small fish. True, the commissioner is authorized to close against seining any of our coastal waters whenever he believes it is best for the protection and increase of fish life, and this law has been resorted to in a few cases where certain waters were known to be particularly well suited

for feeding grounds for young fish, but in every case where the commissioner has closed such waters the commercial men have entered a protest claiming discrimination and a lack of scientific knowledge on the part of the commissioner as to the need of such procedure.

Mr. Jefferson describes the attitude of all the better-informed men engaged in the fish business along the whole Texas coast. They maintain that the big landowners, sportsmen, and sport fishermen bring influence to bear on the legislature, which in turn places new restrictions on the fishing industry regardless of the biological facts on which the laws should be based.

When the opinions of various fish dealers along the coast were sought as to the advisability of setting aside certain waters in their territories as breeding areas for fish and closing them to fishing, the commission received the following replies. From Corpus Christi one dealer wrote, under date of February 29, 1924:

We have noted a much greater scarcity of fish in years past than occurs at this time. While, of course, we do not think there is any harm in closing waters or protecting fish (as a matter of fact, it no doubt will do good), yet we do not think our supply of fish is dependent upon this to any extent. We have virtually only two fishing grounds in this locality—Laguna Madre and the Nueces Bay. While, of course, there is fishing in certain parts of Corpus Christi Bay, it amounts to very little. If Nueces Bay and the Laguna Madre were to be closed to seining we might just as well put an end to our business, as we would be unable to catch any fish.

Nueces Bay, however, was closed, and that leaves Laguna Madre as about the only source of the 1925 supply of fish at Corpus Christi, according to this dealer. Another paragraph from the same letter might be quoted in its entirety, as it throws light on how the closed season on seines affected the industry:

Personally, if it were necessary to choose between the two, we would rather see certain territory closed for seining than have a law similar to the one that was in effect two years ago with regard to the closing against seining during summer months. This law resulted in great hardship to the dealers in that it was necessary to change the type of net used, which caused considerable delay and was very expensive. The summer nets never paid for themselves and were quite rotten by the time the next season came. Then, again, as you may be aware, it caused a large amount of illegal seining to be done at that time, which it was almost impossible to stop. This also tended to create a certain amount of unrest and dissatisfaction among those honest Mexican fishermen who tried to obey the law and yet could not be satisfied with seeing others make money illegally while they could not. It is much easier to enforce a law when the water itself is closed than when the use of certain nets is permitted in those waters and other nets are prohibited. We would almost rather see the whole area closed for two months than to return to this law.

This clearly illustrates, without further explanation, the effect of a law against certain seasonal gear.

A letter from another Corpus Christi dealer contained this:

We would not care to go on record as recommending that certain waters and bays in our immediate territory be closed to the use of nets and seines for the reason that already the existing laws, regulations, and restrictions are such that if any more restrictions and regulations are added to our statutes, so as to include any more waters and territories, they would be prohibitive, and as a consequence in time the industry would be destroyed.

A letter from a fish dealer of Matagorda contains the following:

While in favor of all measures of any real benefit for the conservation of marine life, we are certainly of the opinion that definite information should be secured before further waters are closed to commercial fishing. It has become a problem to get fish in the waters adjoining this point, and it will take only a few more restrictions to leave us with a bunch of useless seines and nets.

The aim of this report is not to overemphasize the grievances of the fishing interests in particular, but we merely mention in passing that such grievances exist. The reaction against existing regulations is almost the same from Galveston to the border. The industry is greatly alarmed and fears it will be "lawed" out of business. At a meeting of the Texas fisheries association, held at San Antonio on August 3, 1925, this subject was warmly discussed. Representative dealers, the State commissioner and other officers, as well as the writers of this report were present. The essence of the discussion was that because of the lack of adequate representation in the legislature the fishing industry is being smothered by laws put through by those who consciously or unconsciously are working against the best interests of the fisheries of Texas.

Just what effect the regulations have upon the fish life it is difficult to determine, for, as has been said before, no evidence upon this subject exists. There is no doubt that the closing of certain areas that frequently are rich fishing grounds, the stopping of summer seining, and similar restrictions reduce the total catch appreciably. If overfishing really exists, such measures undoubtedly will tend to remedy the condition, but the application of restrictions so distributed as to do the least harm to the commercial fishery and the most good to the species requiring protection is a different and very important matter. The general principles [11] underlying this subject, however, are imperfectly understood and are therefore proper objects of biological investigation.

Such is the condition of the fisheries in Texas at the present day. While it might be said that a few of those engaged in the fishing business are greedy and selfish, we believe that the majority of fishermen and fish dealers have the future welfare of the business at heart. They claim to want wise conservation measures and the wise enforcement of them; and this, we believe, is the attitude of the present fish, game, and oyster commission.

RECOMMENDATIONS

This report has emphasized the importance of knowledge of the fishery and of the need and method of protection as the basis for rational conservation. A successful fishery administration must provide the machinery necessary to obtain this knowledge and to obtain and carry into effect regulatory legislation.

It is plainly evident from the foregoing sections that these elements are wanting in varying degrees in the Texas fishery administration. The following recommendations are offered, therefore, in the hope of pointing the way to correcting these deficiencies:

1. The adoption of a system of collecting adequate fishery statistics, made permanent by enactment into law.
2. The adoption of a program of biological investigation.
3. The reorganization of the present fishery administration, modified to permit the development of a permanent policy, and the retention of a permanent technical personnel.

[11] See "The Scientific Investigation of Marine Fisheries," etc., by W. F. Thompson. Fish Bulletin No. 2, California Fish and Game Commission. Sacramento, 1919.

FISHERY STATISTICS

A system of fishery statistics designed to indicate the relative abundance of fish rather than to give the actual amount of the catch is the basis upon which the ability to recognize and control depletion rests. It is impossible to regulate a fishery intelligently without knowing both the fact and the cause of an actual decline of a particular species in any locality. As previously pointed out, the boat catch in most cases is recognized as a reliable index of abundance. Therefore, the proposed system of statistics includes the following details:

1. A record of the daily catch of each species of fish by each individual fishing boat or crew. This record can be collected most easily at the time of the first sale of the fish by providing all dealers with manifolding receipt books upon which the details of the sale may be recorded. A duplicate copy, which is to be the property of the State commission, should be collected and filed for compilation and analysis, thus providing a record of the fluctuating yield of each species.

2. A record of the number and type of boats and vessels and the amount of gear used from year to year. This record should be supplementary to the records of yield and should gage the changes in the above index of abundance—the boat catch. It should be collected annually, by requiring the licensing of all boats, and should be recorded when fishermen's licenses are issued, preferably at the beginning of the fiscal year.

While the preparation of the above records should be under the supervision of a trained fishery biologist, the actual collection of the data on the fish receipts and the registration of boats could be done by the regular fishery deputies in each district and records forwarded periodically to the central office. Indeed, the whole system should be so organized as to work automatically, and it should be affected as little as possible by the personality of the collectors. Furthermore, to insure permanency, the system should be enforced by law.

3. Special biological statistics of the species particularly threatened by depletion should supplement the more general records. Statistics should be gathered in a systematic manner to show changes in the abundance of the various age classes in the fishery. Shifting localities and changing methods also should be recorded, and these should be coordinated with the more general biological investigations recommended in the succeeding paragraphs.

That such a system of statistical examination of the fisheries is not impossible or impractical is demonstrated by the experience of the State of California, where it was developed and has been in smooth, successful operation for six years. The system is described in biennial reports of the California Fish and Game Commission,[12] and illustrations of its utility are beginning to appear in various fishery publications.[13]

Such a system is in reality a form of industrial insurance, for protection is afforded to the investment of capital and the development of the industry; unwise expansion is avoided, for depletion

[12] See particularly "Report of the Department of Commercial Fisheries," by N. B. Scofield. Twenty-eighth Biennial Report, Fish and Game Commission, 1922-1924. Sacramento, 1925.

[13] See particularly "Preliminary Investigation of the Purse-Seine Industry of Southern California," by Tage Skogsberg. Fish Bulletin No. 9, California Fish and Game Commission. Sacramento, 1925.

of the supply can be detected before disaster occurs; and the smothering of activity by irresponsible and hasty legislation is prevented because the system provides reliable information as to the fisheries. In short, exact knowledge of the state of the fisheries, and this alone, makes rational control possible.

BIOLOGICAL INVESTIGATIONS

The foregoing recommendations concerning the adoption of fishery statistics deal with the powers and obligations of the State government. The fisheries are the property of the State, and the State alone has the legal authority for enforcing such a system and making it functional. The responsibility for starting a program of biological investigations, however, rests upon both State and Federal Governments, for fish do not recognize State boundaries and the problems are therefore both local and general.

At the request of the present fish, game, and oyster commissioner and other interested persons the Bureau of Fisheries is undertaking a program of biological investigations, in which the present paper represents the initial step. These investigations are designed to answer the outstanding questions concerning the present and future supply of the more important commercial fishes and to pave the way for further studies of a more detailed and local nature. These later studies should be continued, in the main, by State investigators. Cooperation with the Bureau of Fisheries by the State authorities should include the furnishing of both personnel and equipment, and every evidence is shown that such cooperation will be fully accorded. It should be the function of the Federal Government to consider the larger phases of fishery biology and to coordinate the activities of the various States. The yield of the Texas fisheries must be studied in relation to the fisheries of the entire Gulf, for conservation in Louisiana undoubtedly influences the yield in Texas. It must be the duty of the State, however, to maintain strict watch of the changes in both yield and composition of each fishery in order that it may be known when and how to protect the supply.

REORGANIZATION OF THE FISHERY ADMINISTRATION

The unsatisfactory organization of the State fishery administration in Texas has long been recognized. Commissioner Sterret pointed out the undesirable condition in his report for 1919, when he said: "The department of game, fish, and oysters should be changed * * *. By statute the commissioner is appointed by the governor for a term of two years, our constitution prohibiting terms of appointive officers for a longer time. There is not a man living who can in that time ever learn the geography of the State or the bays, inlets, and rivers of it, though such knowledge is necessary to the enforcement of the laws and the administration of the department's affairs." Thus he sums up both the need for and the difficulty of reorganization. Under this system the development of a permanent policy toward the fisheries and the retention of a reasonably permanent technical staff obviously are impossible.

Regardless of the practical or legal difficulties in the way of effecting a change, it will not be amiss to mention the changes in organization

that will produce desired results as far as the administration of fisheries is concerned.

1. The game, fish, and oyster commission should consist of several members who represent diverse interests and who should hold office without compensation for six years. One-third of this board should retire every two years, so that at all times two-thirds of the board would have had at least four years' experience. This board should have broad discretionary powers, which should be shared with the executive head. An executive head, as well as other necessary executive and legal officers, should be provided.

Commissioner W. W. Boyd, in his report for 1924 (p. 8), repeated and emphasized the difficulties due to the short term of the commissioner and the evils resulting from frequent changes of administration. He also urged the necessity of reorganization of the department, and sketched a plan essentially the same as that presented here. The changes advocated by Mr. Boyd are fundamental and would benefit all activities of the department. The additional recommendations here presented apply particularly to the commercial fisheries and are essential to their proper administration.

2. A division of commercial fisheries, distinct from the division of game, should be given jurisdiction over all commercial fisheries, including oysters. This division should have an executive head, who should have as his first assistant the State fisheries biologist.

3. The fisheries biologist should supervise the collection of fishery statistics and such biological investigations as are necessary to bring to light depletion and to indicate methods of protection. He should be provided with necessary technical or clerical assistants. The fisheries biologist should be hired under contract for several years at a salary comparable to that of professors in State universities. His appointment should be safeguarded from the abuse of being open to incompetent persons and should be entirely free from political influence. This could be accomplished by nomination of the candidate by a committee composed of the State commissioner, the United States Commissioner of Fisheries, and the president of the State university.

The foregoing outline is not intended as a complete plan for the reorganization of the State department of game, fish, and oysters, but only to point out changes necessary for the efficient administration of a fishery conservation program. By such a plan a responsible controlling body with discretionary powers and capable of developing a permanent policy of fishery regulation would be formed. A "practical" man would head the fishery department and have the advice of a trained fishery biologist. The fishery biologist would be charged with the responsibility of carrying on statistical and biological inquiries of a nature to show the real abundance of each important species, the effects of overfishing, and to indicate protective measures for such species as are shown to be suffering depletion.

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FISHERY INDUSTRIES OF THE UNITED STATES, 1925[1]

By Oscar E. Sette

Assistant in Charge, Division of Fishery Industries

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REVIEW OF CONDITIONS IN THE FISHERY INDUSTRIES, 1925

While the year 1925 marked no spectacular changes in the fishing industry, it compared very favorably with the immediately previous years. Vessel landings at the New England ports were above normal in quantity due to unusually large landings of mackerel and haddock. Although the average price declined slightly, the total value of products was substantially greater than in 1924. Seattle landings were somewhat below those of 1924 in quantity and value. The canning industry produced greater quantities of nearly all varieties of canned fishery products, the total value being considerably above that of recent years. By-products also were produced in larger quantities and were of higher value. There was a 6 per cent reduction in the amount of fish frozen, accounted for largely by the exceptionally poor catch of ciscoes on the Great Lakes. The average holdings also were lower than in 1924, though considerably above the 5-year average. Exports of domestic edible fishery products showed an upward trend, while imports for consumption were lower, the increase or decrease in each case being slight.

According to the most recent statistics available for the various geographical sections of the United States and Alaska, the fisheries and fishery industries employ over 191,000 persons and represent an investment of nearly $201,638,000. The annual sales of fishery products by fishermen amount to about 2,878,000,000 pounds, valued

[1] Appendix V to the Report of the United States Commissioner of Fisheries for 1926. B. F. Doc. 1010.

at about $97,500,000. The output of canned fishery products and by-products in 1925 was valued at $95,177,000. The amount of fish frozen during the year was about 91,165,000 pounds, and the average monthly holdings of frozen fish were about 44,084,000 pounds. In the foreign trade of the United States the domestic exports of fishery products attained a value of nearly $21,263,000, and the imports for consumption totaled nearly $49,031,000. A large portion of the unfavorable balance is accounted for by the importation of large amounts of pearl-shell products and whale oils, which is not offset by an appreciable exportation of similar products.

Statistical summary of fisheries of the United States and Alaska

Sections	Persons engaged	Capital invested	Products	
	Number		*Pounds*	*Value*
New England States, 1924	24, 513	$28, 561, 824	406, 822, 165	$18, 818, 132
Middle Atlantic States, 1920–21	55, 244	38, 774, 431	863, 681, 626	24, 407, 785
South Atlantic States, 1923	16, 298	8, 505, 259	228, 747, 930	5, 087, 340
Gulf States, 1923	17, 793	10, 535, 905	160, 324, 042	8, 096, 650
Pacific Coast States, 1922–23	22, 270	28, 651, 490	409, 914, 397	18, 935, 136
Mississippi River division, 1922	19, 122	7, 345, 034	105, 733, 734	4, 503, 521
Great Lakes, 1922	8, 039	12, 046, 458	108, 732, 443	6, 689, 611
Lake of the Woods and Rainy Lake, 1922	123	139, 955	1, 677, 999	110, 022
Alaska, 1925	27, 685	67, 077, 495	594, 901, 143	10, 232, 042
Total various years, 1920–1925	191, 087	201, 637, 851	2, 880, 535, 479	96, 880, 239

NOTE.—In the statistics for the Pacific Coast States in this table the persons and investment are for 1922 and the products are for 1923.

The fishery industries as a whole seem to be in a more prosperous and stable condition than in any year since the postwar depression. They are making perceptible progress in the improvement of technological methods also.

In the fresh-fish field there has been a large increase both in the total amount of fish filleted and in the number of concerns throughout the country that have begun this practice. This improved method of marketing is doing much to popularize and increase the consumption of fish. It also tends to eliminate waste by concentrating large enough amounts of offal in one place to make its manufacture into fish meal profitable. The bureau has shown the industry how to utilize this material to good profit.

The quality of canned salmon was better and the improvement in Maine sardines was particularly marked. The new process of preparing sardines, developed by the bureau, is now being adopted and will help in improving their quality. In California machines for cutting sardines are coming into use. This will help to lower costs and free the canners from labor difficulties. In California, too, the canners voluntarily asked the State board of health to include their establishments in the regular inspection of canning establishments.

In the menhaden industry definite steps have been taken toward improving the quality of fish meal and oil by installing refrigerating machinery for brine cooling fish aboard ship. Steamers so equipped can be operated to much better advantage because it is seldom necessary to return to port without a reasonable load of fish. Also, it is possible to go to the best fishing grounds instead of being compelled to fish close to the factory.

The fishing industry made definite plans for carrying on a national campaign to increase the consumption of fish. This should bring about valuable changes, as a good part of their efforts are to be expended in improving technological practices.

SUMMARY OF OPERATIONS

STATISTICS

Monthly and annual statistics were collected and published regularly during 1925, as follows: The collection and monthly publication of the statistics of the landings of fish by vessels at the ports of Boston and Gloucester, Mass.; Portland, Me.; and Seattle, Wash.; with publication of annual bulletins summarizing these landings for the year; monthly publication of statistics on the cold-storage holdings of fish collected by the Bureau of Agricultural Economics, Department of Agriculture; collection of the statistics of quarterly production, consumption, and holdings of oils in the fishery industries for the use of the Bureau of the Census; collection and publication of the statistics on the production of canned fishery products and by-products of the United States and Alaska for 1925; collection of statistics on the shad and alewife fishery of the Potomac River for 1925; collection of statistics of the shad fishery of the Hudson River for 1923 and 1924; and the securing of statistics on the quantities and value of sponges handled by the Tarpon Springs Sponge Exchange.

General statistics on the fisheries of the Gulf States for 1923, which were collected during 1924, were compiled during the past year and published in summary form. A complete and detailed account is contained in this report. The fisheries of the New England States were canvassed and compiled for 1924 and are included in this report.

With the completion of the above-mentioned statistics the following geographical sections will have been canvassed for the years indicated: New England States, 1924; New York, New Jersey, Pennsylvania, and Delaware, 1921; Maryland and Virginia, 1920; South Atlantic and Gulf States, 1923; Pacific Coast States, 1922; Great Lakes and Mississippi River and tributaries, 1922.

The system used in collecting statistics for various geographic sections at intervals of several years is unsatisfactory, especially from the standpoint of the fishery conservationist and administrator. Some fisheries are particularly subject to extraordinary fluctuations. The catch of a single species in one year may be double that in the next, and with statistics available only at intervals of about five years it is exceedingly improbable that they depict the true nature of the trend. If in one survey an unusually productive year be chanced upon and if about five years later a poor year be encountered, it would look as though the fishery were in an alarming condition. If, on the contrary, the first survey was made in a poor year and the next one in a good year, the reverse would be true. As a matter of fact neither conclusion would be correct. Of course, over a long period of time—say, 30 years—a progressive decline would be reflected in the periodic statistics; but in a relatively short period—say, a decade—only annual statistics could truthfully show the trend in the yield of the fisheries. Unless a decline in catch were detected

in a relatively short time it would be impossible to meet the need for protection intelligently and preserve the fishery for future years.

As the primary function of the Bureau of Fisheries is the direction of conservation activities, this lack of vital statistical information should not be permitted to continue. Means of supplying the necessary data have been canvassed thoroughly, and it is believed that rectification must, in part, be the duty of the States.

The fisheries are the property of the individual States. Most of these have assumed the responsibility of regulation and patrol. Thus, if their fisheries fail, the States themselves are responsible; and if they prosper, it will be due largely to the wisdom and farsightedness of State administrators. Adequate statistics are indispensable in the conservation of the fisheries, and the entire responsibility for their collection can not be shifted to the Federal Government. The duty of collecting such records plainly devolves upon the State governments. The Bureau of Fisheries, with its limited funds and personnel, has been able to meet the demands of the situation to a limited extent, but it is incapable of collecting statistics annually and in such detail as is required. It can, however, properly assume the task of coordinating the statistics collected by the States and is already active in this field. In one region (the Pacific coast) there has been sufficient progress to make it possible for the bureau to summarize the statistics collected by supplementing them with a limited amount of field work. The results of this effort, applied to the year 1923, appeared in the Fisheries Industries Report for 1924, and the work has continued during the past year in collecting and compiling statistics for 1924.

Statistics of the crab fishery.—Investigations of the crab fishery of the Chesapeake Bay, mentioned in the last report, were continued during 1925, the States of Maryland and Virginia cooperating by contributing the services of one man, each, to work under the direction of the Bureau of Fisheries. This investigation was undertaken in order to meet urgent demands on the part of the crab industry for an investigation that should yield the information necessary to halt the decline in the yield of crabs that was felt severely at that time. As many of the important biological features of the blue crab had been studied carefully and now are well understood, the present investigation was mainly of a statistical nature. The following questions demanded answers: 1. Is the abundance of crabs actually declining? 2. Are the crab supplies of Maryland and Virginia independent of each other? 3. Is there preventable waste in the practices of the crab fisheries and industries? 4. What recommendations can be advanced to effect a remedy?

The first question, as to abundance, was found to be somewhat difficult to answer. The total yield shown by the periodical canvasses of Maryland and Virginia indicated a sharp decline when 1915 and 1920 statistics were compared. There were no statistics, however, for the intervening years nor for years since 1920, and because the total yield is not a good indicator of abundance it was found necessary to collect further statistics on this subject. From the books of several concerns it was found possible to determine the average catch per boat, annually, back to 1917 in the dredge fishery and to 1919 in the trot-line fishery. These, together with previously published statistics on the average catch per boat, indi-

cated that a sharp decline in the fishery occurred subsequent to 1908 and reached one of its lowest marks in 1915. Since then there have been rather large fluctuations in the average yield per boat, but the general tendency has been downward. This has established, beyond reasonable doubt, the fact that there has been a considerable decline in abundance during the past 18 years.

In answer to the second question, with regard to the independence of the Maryland and Virginia fisheries, similar statistics on average catch per boat indicated that the fisheries in the two States were interdependent, for it was found that when a good season was experienced in Maryland there was also a good one in Virginia, and the poor years likewise coincided. This was shown by the life-history studies of Churchill.[2] He found that spawning occurred mainly in Virginia waters, that the young gradually moved up the bay into Maryland waters as they grew, and that when maturity was reached most of the females migrated back to Virginia waters to spawn. In order to corroborate this some tagging experiments were undertaken. The one in which 1,000 tagged crabs were released in Maryland waters in the fall of 1925 yielded data of great interest. Twelve of the crabs so released migrated southward into Virginia waters, where they were recaptured by dredges. All but one were females. Actual count of over 9,000 matured crabs taken in the dredge fishery throughout the season of 1924–25 showed that 77 per cent were females. The reverse was true in Maryland, where 69 per cent of the trot-line crabs were males. Thus, four lines of investigation all pointed to the same conclusion—that Maryland and Virginia are interdependent so far as the crab fishery is concerned.

In answer to the third question, as to waste, by taking statistics on the number of "peeler" crabs bought by the shedder houses and the number of soft crabs sold by them it was found that in the season of 1924 an average of 53 per cent was lost before moulting. This constituted the most important loss in the fishery. Second in importance as a loss to the fishery was the taking of buckram crabs. These are of no economic value whatsoever, but if allowed to remain in the water would become valuable hard crabs.

In order, therefore, to halt the decline in abundance of crabs, the following recommendations were made: (1) That the taking of sponge crabs be prohibited at all times; (2) that the extent of all forms of crab fishing be reduced 30 per cent; (3) that in order to prevent waste all crabs having a new soft shell fully formed under the outer hard shell be designated "peeler" crabs; (4) that none but "peeler" crabs be accepted by shedder houses; and (5) that the taking of buckram crabs be prohibited at all times.

In order to ascertain the effect these changes would have, it was recommended further that provision be made for the collection of statistics and biological data throughout future years; and in order that the findings might be acted upon it was recommended that the State fish commissions be empowered to change regulations, subject to the approval of their respective governments.

The complete report, setting forth the results of the investigations and including these recommendations, was distributed throughout

[2] Life history of the Blue Crab, by E. P. Churchill, jr. Bulletin U. S. Bureau of Fisheries, Vol. XXXVI, 1917–18 (1919), pp. 91–128, 2 text figs., Pls. XLVII–LV, Bureau of Fisheries Document No. 870. Washington.

the crabbing industry and was furnished other interested persons, and as a result during its last session the legislature of Virginia passed a law for the protection of sponge and buckram crabs and adequately defining the "peeler" crabs. It is fully expected that these recommendations will be acted upon in Maryland, also, when its legislature next meets. Arrangements have been made to carry on the collection of statistics of the crab fishery with the cooperation of the two States.

Statistics of the mackerel fishery.—One of the greatest difficulties encountered in the important mackerel fishery of the Atlantic coast is the extraordinary fluctuation in the abundance of this fish. The uncertainty as to whether or not the fish will be abundant in any season has caused great loss to the fishermen in outfitting themselves for fishing as well as alternate disastrous gluts and periods of scarcity in the market, which can not be avoided unless some means of forecasting the supply can be devised. At present nothing definite is known as to the nature of these fluctuations except with regard to their magnitude, but fisheries science has progressed to the point where the character and causes of such fluctuations make understanding and forecasting possible if suitable statistics on the amount, character, and the fishing effort involved in producing the yield are available. The foundation for obtaining such statistics was laid in 1925. The work done in that year necessarily was of a preliminary nature, but as a result it was found that it will be necessary to take two major series of statistics—the first on the fishing effort and the yield, collected so as to permit of separate compilation for the various fishing localities; and the second on the sizes of mackerel, based on representative samples of the catch taken continuously throughout the season in all of the more important regions.

In making this preliminary survey advantage was taken of every possible opportunity to cooperate with the division of scientific inquiry in the collection of biological data, and during the course of the survey much material for a study of the life history of the mackerel and its migrations was collected.

TECHNOLOGICAL INVESTIGATIONS

Conservation should be applied to fishery products as well as to fish life. If there be waste in preserving and marketing fish or in making use of by-products, true conservation is not effected. The bureau is doing much through technological research to bring about more efficient utilization of fishery products by improving existing and developing new and better equipment, methods, products, and practices within the various branches of the fishing industry, and by demonstrating the proper utilization of wastes and by-products. Few realize the importance of well-directed, adequately supported technological research. Rapid progress in industry, and this applies particularly to the fisheries industries, depends largely on such work combined with the application of sound business principles.

Work was continued throughout the year on three major lines of research—preservation of nets, canning of sardines, and utilization of by-products. Steps also were taken toward improving American methods of manufacturing caviar. Progress only will be reported upon here, as these investigations were discussed at length in the report for 1924.

Canning of sardines.—Efforts to bring about the commercial development of a new process of preparing sardines developed by the bureau are meeting with success. Two small plants in Maine and one in Canada erected equipment and used the new process, and the product prepared by them is being received favorably.

Preservation of nets.—Large-scale practical tests of copper oleate and copper oleate-copper paint mixtures were conducted in cooperation with fishermen at several points on the Atlantic coast. These tests, which are still under way, are being made to show the real saving that can be achieved from the proper application of copper compounds to different kinds of gear and to learn, if possible, how to lower the cost of treatment. They will have to be continued at least one season longer before conclusive results can be obtained.

Utilization of by-products.—Methods of manufacturing fish meal and oil in the United States were studied thoroughly during the first half of the year. Research was then begun to reduce the losses in protein and oil wasted in press liquors now discarded. This work must be carried further before a report can be made upon it.

As a sanitary measure, the State of Texas has considered requiring all shrimp canners to utilize their waste products. When informed of this, the bureau, cooperating with the State, studied the situation and advised what kind of process and equipment were best suited for this purpose. It was possible, also, to show that a reasonable profit usually could be made from such operations. Similar attention was given to the utilization of market waste, in particular the waste from haddock-filleting operations. This work is being continued.

Preparation of sturgeon caviar.—During the sturgeon season on the Delaware River the bureau took advantage of an opportunity to give demonstrations before fishermen and others of the Russian method of preparing caviar. Such instruction was given at a number of places by a Russian skilled in foreign methods. Russian caviar is of the highest quality, and a knowledge of the methods used in its preparation will assist American fishermen in making caviar of high quality.

PUBLICATIONS OF THE DIVISION

During the calendar year 1925 the following publications, prepared in this division, were issued. This list does not include the monthly statistical bulletins for Boston and Gloucester, Mass., Portland, Me., and Seattle, Wash., nor the monthly publication of the cold-storage holdings of frozen fish.

DOCUMENTS

Iodine content of preserved sea foods. By Arthur W. Wells. 8°, 4 pp. Document No. 979.

Mild curing of salmon in California. By W. L. Scofield. 8°, 14 pp. Document No. 983.

Pearl Essence: Its history, chemistry, and technology. By Harden F. Taylor. 8°, 22 pp., 1 fig. Document No. 989.

STATISTICAL BULLETINS

Statement, by fishing grounds, of quantities and values of certain fishery products landed at Seattle, Wash., by American fishing vessels during the calendar year 1924. Statistical Bulletin No. 641.

Statement, by months, of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American fishing vessels during the calendar year 1924. Statistical Bulletin No. 642.

Statement, by fishing grounds, of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American fishing vessels during the calendar year 1924. Statistical Bulletin No. 643.

Pacific coast salmon pack, 1924. Statistical bulletin.

Fisheries of the Pacific Coast States, 1922. Statistical Bulletin No. 647.

Fisheries of the United States, 1918–1923. Statistical Bulletin No. 648.

Fisheries of the South Atlantic States, 1923. Statistical Bulletin No. 652.

Canned fishery products and by-products of the United States and Alaska, 1924. Statistical Bulletin No. 657.

Fisheries of Alaska, 1924. Statistical Bulletin No. 660.

Fisheries of the Gulf States, 1923. Statistical Bulletin No. 670.

CANNED FISHERY PRODUCTS AND BY-PRODUCTS OF THE UNITED STATES AND ALASKA IN 1925

The fish-canning and by-products industries experienced a most satisfactory year during 1925, producing $80,577,138 worth of canned products and $14,600,198 worth of by-products, a total of $95,177,336. This is the largest total in recent years and is 73 per cent greater than in 1921. Both canned fishery products and the by-products contributed to this increase through substantial gains in the value of canned salmon, sardines, tuna, and oysters and the increased production of the by-products of the sardine industry in California and the herring industry in Alaska.

Comparative statistics of the value of canned fishery products and by-products of the United States and Alaska, 1921 to 1925

Year	Canned products	By-products (including menhaden)	Total
1921	$46,634,706	$8,351,827	$54,986,533
1922	60,464,947	11,390,693	71,855,640
1923	72,445,205	12,634,590	85,079,795
1924	72,164,589	10,308,990	82,473,579
1925	80,577,138	14,600,198	95,177,336

CANNED PRODUCTS

With the exception of shrimps and clams, the value of all of the more important canned products was greater in 1925 than in 1924 and a few years previous. Salmon, as usual, was the most important item, constituting 59 per cent of the value; sardines were next with 16 per cent, tuna next with 10 per cent, and oysters, shrimp, clams, and other miscellaneous products made up the remaining 15 per cent.

Comparative statistics of the value of canned fishery products, 1921 to 1925, inclusive

Year	Salmon	Sardine	Tuna	Oyster	Shrimp	Clam	Other	Total
1921	$28,867,169	$6,307,362	$3,074,626	$2,179,271	$3,804,781	$1,166,507	$1,234,990	$46,634,706
1922	38,420,717	9,111,589	4,511,873	2,423,616	3,064,087	1,716,365	1,216,700	60,464,947
1923	45,533,573	9,896,796	6,914,760	2,720,073	4,381,534	1,710,616	1,287,853	72,445,205
1924	42,401,602	12,636,599	5,756,586	2,478,044	4,608,950	2,161,389	2,121,419	72,164,589
1925	47,369,507	13,097,318	8,499,080	3,721,159	3,782,819	1,850,378	2,256,877	80,577,138

Salmon.—In 1925 salmon were packed at 129 canneries in Alaska, 41 in Washington, 20 in Oregon, and 2 in California. Compared with the previous year, this was an increase of 6 plants in Alaska and 9 in Washington and a decrease of 2 in Oregon. The combined output of the 192 plants operated in 1925 amounted to 6,018,550 cases, valued at $47,369,507. Of this total 1,558,613 cases, valued at $15,379,976, were produced in the Pacific Coast States, and 4,459,937 cases, valued at $31,989,531, were packed in Alaska. The Alaska pack was somewhat smaller than in the previous year, mainly because of a decreased yield of red and pink salmon. Although the pack in the Pacific Coast States was larger than in 1924, the increase was not sufficient to offset the smaller Alaska pack, so that the total pack of 1925 was smaller than that of 1924 by 235,027 cases, or 3.8 per cent. This decrease in quantity was more than compensated by increased prices, making the total value of the pack greater than that of the previous year by $4,967,905, or 11.7 per cent.

Pack of canned salmon, Pacific Coast States and Alaska, 1925

Products	Pacific Coast States						Alaska	
	Washington		Oregon and California		Total		Southeast	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*	*Cases*	*Value*
King, chinook, or spring:								
1-pound tall	38,077	$308,676	21,733	$169,365	59,810	$478,041	6,594	$69,841
1-pound flat	43,274	588,836	94,548	1,252,920	137,822	1,841,756	4,663	63,734
1-pound oval	563	11,260	4,012	80,230	4,575	91,490		
½-pound flat and oval	86,296	1,324,673	144,135	2,254,059	230,431	3,578,732	748	12,704
Total	168,210	2,233,445	264,428	3,756,574	432,638	5,990,019	12,005	146,279
Red or sockeye:								
1-pound tall	3,412	48,450			3,412	48,450	108,499	1,353,656
1-pound flat	24,505	352,872			24,505	352,872	6,242	85,289
½-pound flat	86,343	1,588,707	4,127	75,946	90,470	1,664,653	28,947	463,309
Total	114,260	1,990,029	4,127	75,946	118,387	2,065,975	143,688	1,902,254
Coho or silver:								
1-pound tall	138,115	1,408,773	37,539	369,384	175,654	1,778,157	81,592	778,462
1-pound flat	30,093	331,023	30,053	288,509	60,146	619,532	3,960	44,472
½-pound flat	35,729	500,213	36,038	415,158	71,767	915,371	5,800	89,810
Total	203,937	2,240,009	103,630	1,073,051	307,567	3,313,060	91,352	912,744
Humpback or pink:								
1-pound tall	448,502	2,381,546	2,947	15,649	451,449	2,397,195	1,680,101	8,850,421
1-pound flat	34,284	205,704	780	4,680	35,064	210,384	185	928
½-pound flat	64,734	543,765	128	998	64,862	544,763	27,170	213,360
Total	547,520	3,131,015	3,855	21,327	551,375	3,152,342	1,707,456	9,064,709
Chum or keta:								
1-pound tall	78,300	346,086	26,498	116,591	104,798	462,677	845,008	3,705,085
1-pound flat	167	768	72	331	239	1,099		
½-pound flat	18,736	117,658	9,595	59,876	28,331	177,534	2,905	20,133
Total	97,203	464,512	36,165	176,798	133,368	641,310	847,913	3,725,218
Steelhead:								
1-pound tall	70	910	507	6,591	577	7,501		
1-pound flat	173	2,318	9,511	127,447	9,684	129,765		
½-pound flat and oval	1,081	17,300	3,936	62,704	5,017	80,004		
Total	1,324	20,528	13,954	196,742	15,278	217,270		
Grand total	1,132,454	10,079,538	426,159	5,300,438	1,558,613	15,379,976	2,802,414	15,751,204

Pack of canned salmon, Pacific Coast States and Alaska, 1925—Continued

Products	Alaska—Continued						Grand total	
	Central		Western		Total			
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*	*Cases*	*Value*
King, chinook, or spring:								
1-pound tall	13,328	$152,107	18,473	$217,852	38,395	$439,800	98,205	$917,841
1-pound flat	3,965	48,354	200	1,500	8,828	113,588	146,650	1,955,344
1-pound oval							4,575	91,490
½-pound flat and oval	2,007	28,949			2,755	41,653	233,186	3,620,385
Total	19,300	229,410	18,673	219,352	49,978	595,041	482,616	6,585,060
Red or sockeye:								
1-pound tall	316,368	4,107,698	537,151	6,918,868	962,018	12,380,222	965,430	12,428,672
1-pound flat	20,195	264,986	2,320	29,607	28,757	379,882	53,262	732,754
½-pound flat	25,175	430,618	14,779	250,568	68,901	1,144,495	159,371	2,809,148
Total	361,738	4,803,302	554,250	7,199,043	1,059,676	13,904,599	1,178,063	15,970,574
Coho or silver:								
1-pound tall	63,696	596,254	1,354	13,901	146,642	1,388,617	322,296	3,166,774
1-pound flat	3,263	27,714			7,223	72,186	67,369	691,718
½-pound flat	1,330	14,906	15	240	7,145	104,956	78,912	1,020,327
Total	68,289	638,874	1,369	14,141	161,010	1,565,759	468,577	4,878,819
Humpback or pink:								
1-pound tall	396,157	2,025,523	145	678	2,076,403	10,876,622	2,527,852	13,273,817
1-pound flat					185	928	35,249	211,312
½-pound flat	6,835	46,192			34,005	259,552	98,867	804,315
Total	402,992	2,071,715	145	678	2,110,593	11,137,102	2,661,968	14,289,444
Chum or keta:								
1-pound tall	200,128	923,290	30,493	137,646	1,075,629	4,766,021	1,180,427	5,228,698
1-pound flat							239	1,099
½-pound flat	146	876			3,051	21,009	31,382	198,543
Total	200,274	924,166	30,493	137,646	1,078,680	4,787,030	1,212,048	5,428,340
Steelhead:								
1-pound tall							577	7,501
1-pound flat							9,684	129,765
½-pound flat and oval							5,017	80,004
Total							15,278	217,270
Grand total	1,052,593	8,667,467	604,930	7,570,860	4,459,937	31,989,531	6,018,550	47,369,507

NOTE.—The pack of salmon has been reduced to the equivalent of forty-eight 1-pound cans to the case. There were other salmon products, valued at $129,270, not shown in the above table.

Comparative statistics of the pack of salmon in the Pacific Coast States, 1921 to 1925

Year	King, chinook, or spring		Red or sockeye		Coho or silver		Humpback or pink	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*	*Cases*	*Value*
1921	335,854	$4,527,711	104,954	$1,905,647	111,643	$806,678	402,846	$1,732,847
1922	314,126	4,572,607	97,927	1,816,901	204,262	1,533,173	3,551	18,546
1923	384,705	5,790,419	105,336	1,955,549	245,548	1,608,627	445,175	2,211,742
1924	349,014	4,599,759	85,800	1,478,698	231,139	1,774,078	12,778	79,436
1925	432,638	5,990,019	118,387	2,065,975	307,567	3,313,060	551,375	3,152,342

Year	Chum or keta		Steelhead		Total	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*
1921	35,132	$127,659	12,519	$133,883	1,002,948	$9,234,425
1922	87,583	365,303	25,797	326,994	733,246	8,633,524
1923	154,342	769,839	32,157	324,390	1,367,263	12,660,566
1924	247,858	1,192,156	32,073	270,340	958,662	9,394,467
1925	133,368	641,310	15,278	217,270	1,558,613	15,379,976

Comparative statistics of the salmon pack in Alaska, 1921 to 1925

Year	King, chinook, or spring		Red or sockeye		Coho or silver	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*
1921	44,994	$459,897	1,765,798	$15,841,404	106,555	$600,140
1922	30,660	247,673	2,070,658	19,135,696	175,993	962,790
1923	38,343	328,270	1,859,496	17,253,792	164,107	943,318
1924	33,648	299,009	1,447,895	13,803,932	183,601	1,254,551
1925	49,978	595,041	1,059,676	13,904,599	161,010	1,565,759

Year	Humpback or pink		Chum or keta		Total	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*
1921	423,984	$1,788,778	255,495	$942,525	2,596,826	$19,632,744
1922	1,658,423	7,189,494	565,918	2,251,540	4,501,652	29,787,193
1923	2,448,129	11,899,956	525,622	2,447,671	5,035,697	32,873,007
1924	2,601,283	12,837,346	1,028,488	4,812,297	5,294,915	33,007,135
1925	2,110,593	11,137,102	1,078,680	4,787,030	4,459,937	31,989,531

Comparative statistics of the salmon pack in the United States and Alaska, 1921 to 1925

Year	Pacific Coast States		Alaska		Total	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*
1921	1,002,948	$9,234,425	2,596,826	$19,632,744	3,599,774	$28,867,169
1922	733,246	8,633,524	4,501,652	29,787,193	5,234,898	38,420,717
1923	1,367,263	12,660,566	5,035,697	32,873,007	6,402,960	45,533,573
1924	958,662	9,394,467	5,294,915	33,007,135	6,253,577	42,401,602
1925	1,558,613	15,379,976	4,459,937	31,989,531	6,018,550	47,369,507

Sardines.—In 1925 there were 31 plants in Maine, 1 in Massachusetts, and 26 in California engaged in the canning of sardines. The production in Maine and Massachusetts amounted to 1,870,786 standard cases of one hundred ¼-pound cans, valued at $6,716,701, a decrease of 29,139 cases, or 1.5 per cent, in quantity and $474,325, or 6.6 per cent, in value as compared with 1924. In California the production totaled 1,714,913 standard cases of forty-eight 1-pound cans, valued at $6,380,617, an increase of 347,774 cases, or 25.4 per cent, in quantity and $935,044, or 17.2 per cent, in value as compared with 1924.

Pack of sardines, 1925

Sardines (herring)	Maine and Massachusetts		Sardines (pilchard)	California	
	Cases	*Value*		*Cases*	*Value*
In olive oil: Quarters (100 cans)	29,568	$128,025	½-pound oval (48 cans)[1]	30,159	$91,378
In cottonseed oil: Quarters (100 cans)	1,386,285	5,257,175	1-pound oval (48 cans):		
In mustard:			In tomato sauce	1,600,662	5,706,446
Quarters (100 cans)	138,242	532,150	In mustard	57,242	209,141
Three-quarters (48 cans)	208,923	730,197	Soused	5,508	20,455
In tomato sauce: Quarters (100 cans)	15,842	69,154	In other sauces	14,324	51,066
			¼-pound square (100 cans)[2]	28,507	236,951
			½-pound square (100 cans)[2]	[3] 6,960	65,180
Total	1,778,860	6,716,701	Total	1,743,362	6,380,617
Total (standard cases)[4]	1,870,786		Total (standard cases)[5]	1,714,913	

[1] Largely in tomato sauce.
[2] Largely in olive oil.
[3] Includes a few cases packed in 6-ounce tall cans, 100 to the case, and also a few cases packed in 8½-ounce glass jars, 24 to the case, which have been converted to a basis of ½-pound cans, 100 to the case.
[4] Standard case equals one hundred ¼-pound cans.
[5] Standard case equals forty-eight 1-pound cans.

Comparative statistics of the pack of sardines, 1921 to 1925

Year	Maine and Massachusetts		California	
	Cases [1]	*Value*	*Cases* [2]	*Value*
1921	1,399,507	$3,960,916	398,668	$2,346,446
1922	1,869,719	5,750,109	715,364	3,361,480
1923	1,272,277	5,288,865	1,100,162	4,607,931
1924	1,899,925	7,191,026	1,367,139	5,445,573
1925	1,870,786	6,716,701	1,714,913	6,380,617

[1] Standard cases of one hundred ¼-pound cans.
[2] Standard cases of forty-eight 1-pound cans.

Shad and alewives.—Shad and shad roe were canned at 7 plants in Washington, 9 in Oregon, and 1 in California, the production amounting to 14,999 standard cases of forty-eight 1-pound cans, valued at $154,446, of which 12,569 cases, valued at $53,875, were shad and 2,430 cases, valued at $100,571, were shad roe.

Alewives and alewife roe were canned at 6 plants in Maryland, 23 in Virginia, and 2 in North Carolina. The total output amounted to 84,548 standard cases of twenty-four 15-ounce cans, valued at $255,506, of which 9,491 cases, valued at $15,045, were alewives and 75,057 cases, valued at $240,461, were alewife roe.

The packs of these products have increased considerably during the last five years. Though the 1925 pack of alewife roe was somewhat smaller than that of 1924, it was considerably larger than the packs of the previous three years.

Pack of shad and alewives, 1925

Shad	Washington, Oregon, and California		Alewives	Maryland, Virginia, and North Carolina	
	Cases	*Value*		*Cases*	*Value*
½-pound flat (48 cans)	462	$1,447	No. 1 and No. 2 (24 cans)	[1] 9,491	$15,045
1-pound tall (48 cans)	12,338	52,428	Roe: No. ½, No. 1, and No. 2 (24 cans)	[1] 75,057	240,461
Roe:					
½-pound flat (48 cans)	67	1,608			
½-pound oval (48 cans)	4,792	98,963			
Total	17,659	154,446	Total	84,548	255,506
Total (standard cases) [2]	14,999		Total (standard cases) [3]	84,548	

[1] The pack of alewives and alewife roe has been reduced to the equivalent of No. 2, 15-ounce cans, 24 cans to the case.
[2] Standard case equals forty-eight 1-pound cans.
[3] Standard case equals twenty-four 15-ounce cans.

Comparative statistics of the pack of shad and shad roe, 1921 to 1925

Year	Shad		Shad roe		Total	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*
1921	641	$2,455	38	$142	679	$2,597
1922	1,781	9,961	292	8,517	2,073	18,478
1923	2,162	37,165	536	16,288	2,698	53,453
1924	6,470	20,461	1,164	72,932	7,634	93,393
1925	12,569	53,875	2,430	100,571	14,999	154,446

NOTE.—Cases have been reduced to the equivalent of forty-eight 1-pound cans.

Comparative statistics of the pack of alewives and alewife roe, 1921 to 1925

Year	Alewives		Alewife roe		Total	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*
1921	333	$813	43,316	$157,841	43,649	$158,654
1922	1,043	1,994	38,612	137,514	39,665	139,508
1923	1,145	1,915	43,530	169,435	44,675	171,350
1924	3,306	5,118	88,836	332,245	92,142	337,363
1925	9,491	15,045	75,057	240,461	84,548	255,506

NOTE.—Cases have been converted to the equivalent of twenty-four 15-ounce cans.

Tuna and tunalike fishes.—Tuna and tunalike fishes were canned at 22 plants in California, the total output of which amounted to 1,102,471 standard cases of forty-eight ½-pound cans, valued at $8,499,080. Of this, 490,590 cases, valued at $4,292,018, contained albacore; 261,482 cases, valued at $1,745,338, yellowfin and bluefin tuna; 168,177 cases, valued at $997,697, striped tuna or skipjack; 131,159 cases, valued at $1,212,024, "tonno"; 10,090 cases, valued at $61,207, bonito; 13,484 cases, valued at $70,159, yellowtail; and 27,489 cases, valued at $120,637, tuna flakes. All items except bonito and yellowtail show substantial increases when compared with those of 1924, the aggregate increase amounting to 450,055 cases, or 69 per cent, in quantity and $2,742,494, or 48 per cent, in value.

Pack of tuna and tunalike fishes in California, 1925

Sizes	Albacore		Yellowfin		Bluefin		Tuna, bluefin, and yellowfin		Tuna, striped	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*	*Cases*	*Value*	*Cases*	*Value*
¼-pound round (48 cans) [1]	45,445	$258,325	19,761	$81,886	3,904	$17,455	32,678	$145,026	20,340	$82,308
½-pound round (48 cans)	356,237	3,109,764	57,526	371,314	39,407	265,440	94,162	610,583	129,151	764,550
1-pound round (48 cans)	55,815	923,929	4,343	50,898	2,698	33,466	14,067	169,270	14,428	150,839
Total	457,497	4,292,018	81,630	504,098	46,009	316,361	140,907	924,879	163,919	997,697
Total (standard cases) [4]	490,590		76,092		46,755		138,635		168,177	

Sizes	"Tonno"		Bonito		Yellowtail		Tuna flakes		Total	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*	*Cases*	*Value*	*Cases*	*Value*
¼-pound round (48 cans) [1]	228,736	$1,079,338	4,574	$18,658					355,438	$1,682,996
½-pound round (48 cans)	15,905	123,619	[2] 7,803	42,549	10,286	$56,579	[3] 20,221	$86,274	730,698	5,430,672
1-pound round (48 cans)	443	9,067			1,599	13,580	3,634	34,363	97,027	1,385,412
Total	245,084	1,212,024	12,377	61,207	11,885	70,159	23,855	120,637	1,183,163	8,499,080
Total (standard cases) [4]	131,159		10,090		13,484		27,489		1,102,471	

[1] Includes the pack of ⅛-pound round, 96 cans to the case, and ¼-pound round, 72 and 96 cans to the case, and ¼-pound square, 100 cans to the case, which have been converted to the basis of ¼-pound cans, 48 to the case.
[2] Includes a few cases of 1-pound round, which have been converted to a basis of ½-pound round.
[3] Includes a few cases of ¼-pound round, which have been converted to a basis of ½-pound round.
[4] Standard case equals forty-eight ½-pound cans.

Comparative statistics of the pack of tuna and tunalike fishes, 1921 to 1925

Year	Albacore		Bluefin and yellowfin tuna		Striped tuna		"Tonno"	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*	*Cases*	*Value*
1921	456,152	$2,657,266	64,816	$306,486	27,972	$109,929	----------	----------
1922	296,210	2,304,935	168,874	1,047,621	177,995	942,356	13,714	$139,067
1923	310,037	3,106,329	261,773	1,959,812	96,452	578,254	124,416	1,136,814
1924	416,820	4,024,509	65,941	455,048	43,159	239,198	97,304	861,861
1925[1]	518,079	4,412,655	261,482	1,745,338	168,177	997,697	131,159	1,212,024

Year	Bonito		Yellowtail		Total	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*
1921	----------	----------	210	$945	549,150	$3,074,626
1922	10,810	$58,900	4,718	18,994	672,321	4,511,873
1923	15,099	77,906	10,059	55,645	817,836	6,914,760
1924	12,899	94,806	16,293	81,164	652,416	5,756,586
1925	10,090	61,207	13,484	70,159	1,102,471	8,499,080

[1] Includes 27,489 cases of tuna flakes, valued at $120,637.

NOTE.—Cases are on the standard basis of forty-eight ½-pound cans.

Shrimp.—In 1925 shrimp were canned at 87 plants, located as follows: North Carolina, 3; South Carolina, 3; Georgia, 11; Florida, 10; Alabama, 7; Mississippi, 20; Louisiana, 27; Texas, 5; and New York, 1. The total production was 735,714 standard cases of 48 No. 1 cans, valued at $3,782,819, an increase of 2 per cent in quantity and a decrease of 18 per cent in value as compared with 1924.

Pack of shrimp, 1925

Sizes	North Carolina, South Carolina, and Georgia		Florida		Alabama		Mississippi	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*	*Cases*	*Value*
No. 1 dry (4 dozen)	[1] 13,329	$77,221	4,506	$25,451	43,612	$195,665	[2] 46,310	$219,697
No. 1 wet (4 dozen)	50,325	267,486	27,461	161,648	41,578	214,599	126,166	575,772
No. 1½ dry (2 dozen)	6,871	36,069	1,095	6,054	2,300	9,875	4,588	29,300
No. 1½ wet (2 dozen)	61	329	375	2,032	----------	----------	625	2,894
Total	70,586	381,105	33,437	195,185	87,490	420,139	177,689	827,663
Total (standard cases)[3]	69,373	----------	33,180	----------	87,087	----------	176,777	----------

Sizes	Louisiana		Texas		Total	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*
No. 1 dry (4 dozen)	[2] 144,879	$695,349	8,706	$47,611	261,342	$1,260,994
No. 1 wet (4 dozen)	143,370	682,058	28,910	147,742	417,810	2,049,305
No. 1½ dry (2 dozen)	14,070	66,133	----------	----------	28,924	147,431
No. 1½ wet (2 dozen)	747	3,739	----------	----------	1,808	8,994
Total	303,066	1,447,279	37,616	195,353	[4] 709,884	[4] 3,466,724
Total (standard cases)[3]	300,473	----------	37,616	----------	704,506	----------

[1] Includes a few cases packed 4¼ ounces to the can, which have been converted to the equivalent of No. 1, 5-ounce cans.

[2] Includes a few cases packed 4 ounces to the can, which have been converted to the equivalent of No. 1, 5-ounce cans.

[3] Standard case equals 48 No. 1 cans.

[4] In addition to the above, there were packed in 5, 5¼, 5¾, 6¼, and 14-ounce glass jars, and No. 2½, 18-ounce cans, in New York, Florida, Alabama, Mississippi, Louisiana, and Texas, 62,604 cases of shrimp, or 31,208 standard cases, valued at $316,095, making a total of 735,714 standard cases, valued at $3,782,819.

Comparative statistics of the pack of shrimp, 1921 to 1925

Year	Cases	Value	Year	Cases	Value
1921	655, 364	$3, 804, 781	1924	718, 517	$4, 608, 950
1922	579, 797	3, 064, 087	1925	735, 714	3, 782, 819
1923	700, 429	4, 381, 534			

NOTE.—Cases have been reduced to the equivalent of 48 No. 1 cans.

Crabs.—Crabs were canned at 1 plant in Alaska, 1 in Washington, 2 in Virginia, and 1 in Mississippi during 1925. The total output amounted to 4,228 standard cases of twenty-four 15-ounce cans, valued at $52,499. Reference to the table below, which gives statistics for the years 1921 to 1925, shows that while the value of the 1925 pack was greater than that of the previous two years it was only about half that of 1921 and 1922.

Pack of crabs, 1925

Sizes	Alaska, Washington, Virginia, and Mississippi	
	Cases	Value
5, 6, 7½, 8, and 9 ounce (4 dozen)	[1] 2, 427	$32, 771
14, 15, 16, and 17 ounce (2 dozen)	[2] 1, 801	19, 728
Total	4, 228	52, 499
Total (standard cases) [3]	4, 228	

[1] The 5, 6, 8, and 9 ounce cans have been converted to the equivalent of 7½-ounce cans, 4 dozen to the case.
[2] The 14, 16, and 17 ounce cans have been converted to the equivalent of 15-ounce cans, 2 dozen to the case.
[3] Standard case equals twenty-four 15-ounce cans.

Comparative statistics of the value of the crab pack, 1921 to 1925

Year	Value	Year	Value
1921	$115, 800	1924	$35, 944
1922	104, 171	1925	52, 499
1923	47, 023		

Clams.—In 1925 razor clams were packed at 19 plants in Washington, 7 in Oregon, and 12 in Alaska; hard clams at 2 plants in Florida, 1 in Georgia, 1 in South Carolina, 1 in Rhode Island, and 4 in Washington; and soft clams at 23 plants in Maine and 2 in Massachusetts. The total output was 331,586 standard cases of forty-eight 10-ounce cans, valued at $1,850,378, as follows: Razor clams, 110,396 cases, valued at $860,002; hard clams, 38,042 cases, valued at $218,601; soft clams, 32,522 cases, valued at $287,073; and chowders, soups, bouillon, and juices of hard, soft, and razor clams, 150,626 cases, valued at $484,702.

Pack of clams, 1925

Razor clams	Washington and Oregon		Alaska		Total		Hard clams	Florida and Washington	
Whole:	*Cases*	*Value*	*Cases*	*Value*	*Cases*	*Value*	Whole:	*Cases*	*Value*
½-pound (4 dozen)	-------	-------	50	$300	50	$300	1-pound (4 dozen)	2,769	$19,383
No. 1 (4 dozen) and No. 2 (2 dozen)	2,169	$27,618	-------	-------	2,169	27,618	No. 1 (4 dozen)	9,307	66,429
1-pound (4 dozen)	2,119	25,428	5,054	36,803	7,173	62,231	No. 2 (2 dozen)	12,508	71,461
5-pound (½ dozen)	-------	-------	597	3,358	597	3,358	No. 10 (½ dozen)	4,268	23,009
Minced:							Minced:		
½-pound flat (4 dozen)	22,104	154,726	47,248	264,376	69,352	419,102	No. 1 (4 dozen)	[1] 2,621	16,935
No. 1 (4 dozen)	16,770	147,576	22,230	187,214	39,000	334,790	No. 2 (2 dozen)	[2] 3,721	21,384
No. 2 (2 dozen)	[3] 1,632	12,603	-------	-------	1,632	12,603	Total	35,194	218,601
Total	44,794	367,951	75,179	492,051	119,973	860,002	Total (standard cases) [4]	38,042	-------
Total (standard cases) [4]	41,644	-------	68,752	-------	110,396	-------			

Soft clams	Maine and Massachusetts		Other hard, soft, and razor clam products	Maine, Massachusetts, Rhode Island, Georgia, South Carolina, Florida, Washington, and Oregon	
Whole:	*Cases*	*Value*	Chowder and soup:	*Cases*	*Value*
5-ounce (4 dozen)	[5] 42,624	$195,946	No. 1 (2 dozen)	75,951	$132,020
8-ounce (4 dozen)	8,790	58,958	No. 1½ and No. 2 (2 dozen)	[6] 49,046	134,521
10-ounce (2 dozen)	[7] 8,356	32,169	No. 3 (2 dozen)	38,678	172,574
Total	59,770	287,073	No. 10 (½ dozen)	1,023	3,889
Total (standard cases) [4]	32,522	-------	Bouillon and juice: 10-ounce (4 dozen)	[8] 8,816	41,698
			Total	173,514	484,702
			Total (standard cases) [4]	150,626	-------

[1] Includes a few cases packed in ½-pound cans, which have been converted to a basis of No. 1 cans.
[2] Includes the pack of No. 10, ½ dozen to the case, which have been converted to a basis of No. 2, 2 dozen to the case.
[3] Includes a few cases packed in 1-pound cans, 4 dozen to the case, which have been converted to a basis of No. 2 cans, 2 dozen to the case.
[4] Standard case equals forty-eight 10-ounce cans.
[5] Includes a few cases packed in 6-ounce cans, 24 to the case, which have been converted to a basis of 5-ounce cans, 48 to the case.
[6] The pack of No. 2 cans, 2 dozen to the case, has been reduced to the equivalent of No. 1½ cans, 2 dozen to the case.
[7] Includes the pack of 9 and 15 ounce cans, which have been converted to a basis of 10-ounce cans.
[8] The pack of clam bouillon and juice was packed in various sizes, all of which were converted to a basis of 10-ounce cans, 4 dozen to the case.

Comparative statistics of the value of canned clams and clam products, 1921 to 1925, inclusive.

Year	Razor clams	Hard clams	Soft clams	Clam chowders, juices, etc.	Total
1921	$506,591	$138,699	$338,775	$182,442	$1,166,507
1922	876,364	201,270	327,287	311,444	1,716,365
1923	883,535	194,937	308,560	323,584	1,710,616
1924	863,126	271,911	459,882	566,470	2,161,389
1925	860,002	218,601	287,073	484,702	1,850,378

Oysters.—In 1925 oysters were canned at 13 plants in Maryland, 5 in North Carolina, 15 in South Carolina, 7 in Georgia, 6 in Florida, 6 in Alabama, 25 in Mississippi, 4 in Louisiana, and 2 in Texas. The total output was 654,755 standard cases of forty-eight 5-ounce cans,

valued at $3,721,159. This was the largest pack in recent years and represents an increase of 207,274 cases, or 46 per cent, in quantity and $1,243,115, or 50 per cent, in value as compared with 1924.

Pack of oysters, 1925

Sizes	Maryland		North Carolina		South Carolina		Georgia		Florida	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*	*Cases*	*Value*	*Cases*	*Value*
4-ounce (4 dozen)	[1] 13,167	$74,871	100	$560	[1] 11,112	$57,798			800	$3,520
5-ounce (4 dozen)	57,024	361,407	22,922	124,243	70,475	399,925	16,257	$88,406	12,089	67,037
6-ounce (4 dozen)	14,031	138,815			32	288	63	510		
8-ounce (2 dozen)	3,902	22,100	195	702	3,504	17,957				
10-ounce (2 dozen)	15,172	96,622	1,985	11,910	15,685	90,982	643	3,828		
12-ounce (2 dozen)	1,083	9,874								
Total	104,379	703,689	25,202	137,415	100,808	566,950	16,963	92,744	12,889	70,557
Total (standard cases) [2]	103,988		25,143		97,891		16,976		12,729	

Sizes	Alabama		Mississippi		Louisiana and Texas		Total	
	Cases	*Value*	*Cases*	*Value*	*Cases*	*Value*	*Cases*	*Value*
4-ounce (4 dozen)	1,000	$4,800	61,091	$315,703	8,238	$40,895	95,508	$498,147
5-ounce (4 dozen)	45,014	237,262	188,397	964,047	20,866	98,897	433,044	2,341,224
6-ounce (4 dozen)					1,288	9,101	15,414	148,714
8-ounce (2 dozen)	500	2,400	25,935	132,606	1,495	7,352	35,531	183,117
10-ounce (2 dozen)	14,050	74,575	46,328	246,138	2,606	13,030	96,469	537,085
12-ounce (2 dozen)					512	2,998	1,595	12,872
Total	60,564	319,037	321,751	1,658,494	35,005	172,273	677,561	3,721,159
Total (standard cases) [2]	60,264		304,346		33,418		654,755	

[1] Includes the pack of 3-ounce cans, which have been coverted to the equivalent of 4-ounce cans.
[2] Standard case equals forty-eight 5-ounce cans.

Comparative statistics of the pack of oysters, 1921 to 1925

Year	Cases	Value	Year	Cases	Value
1921	442,086	$2,179,271	1924	447,481	$2,478,044
1922	505,973	2,423,616	1925	654,755	3,721,159
1923	524,544	2,720,073			

NOTE.—Cases are on the standard basis of forty-eight 5-ounce cans.

Miscellaneous canned fish.—In addition to the products shown above, miscellaneous canned goods were packed in 1925, as follows: In Maine, Massachusetts, New York, New Jersey, Oregon, and Alaska, 6,906,991 pounds of canned fish and terrapin, valued at $1,221,820, and 608,611 pounds of canned fish roe and caviar, valued at $185,218; and in California, 58,021 cases of fish cakes, abalone, and squid, valued at $258,118; making a total of $1,665,159 worth of miscellaneous canned goods not mentioned elsewhere.

BY-PRODUCTS

The total value of by-products, including the products of the menhaden and whaling industries, amounted to $14,600,198 in 1925, made up of the following items: Fish and whale oils, 13,287,076 gal-

lons, valued at $6,500,191; fish, whale, and shrimp scrap, meal, and bran to the value of $4,650,635; shell by-products, 295,149 tons, valued at $2,382,731; fish glue, 510,816 gallons, valued at $589,064; and miscellaneous by-products to the value of $477,577. The value of the by-products has increased considerably in recent years, the figures being as follows: 1921, $8,351,827; 1922, $11,390,693; 1923, $12,634,590; 1924, $10,308,990; and 1925, $14,600,198.

Production of various by-products, 1925

Products	Maine, Massachusetts and New York		Maryland and Virginia		North Carolina, Georgia, and Florida		Louisiana	
	Quantity	*Value*	*Quantity*	*Value*	*Quantity*	*Value*	*Quantity*	*Value*
Fish scrap and meal:								
Dried, tons	3,891	$196,262	1,465	$48,972				
Acidulated, do	310	7,016						
Pomace, do	2,461	5,364						
Oil:								
Herring, gallons	64,444	23,279	26,839	11,692				
Sperm, do	12,600	6,300						
Cod liver, crude, gallons	138,345	83,268						
Miscellaneous, do	958	699	3,750	1,500	21,351	$11,532		
Liquid glue, do	510,816	589,064						
Miscellaneous by-products[1], pounds	2,909,608	217,951	100,000	10,000	281,796	41,710	2,142,000	$31,394
Total		1,129,203		72,164		53,242		31,394

Products	Alaska, Washington, Oregon, and California		Indiana and Wisconsin		Total	
	Quantity	*Value*	*Quantity*	*Value*	*Quantity*	*Value*
Fish scrap and meal:						
Dried, tons	34,210	$1,735,804			39,566	$1,981,038
Acidulated, do					310	7,016
Pomace, do	3,016	4,050			5,477	9,414
Oil:						
Salmon, gallons	224,516	85,562			224,516	85,562
Sardine, do	3,120,048	1,568,753			3,120,048	1,568,753
Tuna, do	57,825	14,717			57,825	14,717
Herring, do	2,351,152	999,045	92	$55	2,442,527	1,034,071
Whale, do	1,076,148	624,854			1,076,148	624,854
Sperm, do	132,450	53,857			145,050	60,157
Cod liver, crude, do					138,345	83,268
Miscellaneous, do	28,119	11,247	5,331	2,725	59,509	27,703
Liquid glue, do					510,816	589,064
Miscellaneous by-products[1], pounds	982,549	208,180			6,415,953	509,235
Total		5,306,069		2,780		6,594,852

[1] Includes shark hides, fins, and meat, herring skins and scales, stearine, isinglass, agar-agar, fish flour, whale meat, and whale tails, and 1,079 tons of shrimp bran, valued at $31,658. The bran was produced mainly in Louisiana.

NOTE.—The oils produced on the Pacific coast are reported in "Trade" gallons (7½ pounds), and those produced on the Atlantic and Gulf coasts are reported in United States gallons (about 7.74 pounds).

Fish oils.—The production of fish and whale oils in 1925 amounted to 13,287,076 gallons, valued at $6,500,191, as follows: Menhaden, 6,023,108 gallons, valued at $3,001,106; herring, 2,442,527 gallons, valued at $1,034,071; sardine, 3,120,048 gallons, valued at $1,568,753; other fish oils, 480,195 gallons, valued at $211,250; and whale and sperm oil, 1,221,198 gallons, valued at $685,011. The 1925 production was considerably above the normal for recent years because of the greatly increased quantities of sardine and herring oils produced on the Pacific coast.

Production of fish and whale oils, 1921 to 1925

Year	Menhaden		Herring		Sardine	
	Gallons	*Value*	*Gallons*	*Value*	*Gallons*	*Value*
1921	6,260,478	$1,719,892	112,838	$26,735	170,977	$35,760
1922	7,102,677	2,904,833	450,362	150,144	428,859	145,668
1923	7,461,365	3,316,277	945,424	384,053	966,247	424,103
1924	3,923,904	1,817,626	1,324,002	571,399	2,338,711	1,076,903
1925	6,023,108	3,001,106	2,442,527	1,034,071	3,120,048	1,568,753

Year	Other fish oils		Whale and sperm		Total	
	Gallons	*Value*	*Gallons*	*Value*	*Gallons*	*Value*
1921	378,887	(1)	523,101	(1)	7,446,281	$2,078,670
1922	306,430	145,401	2,247,145	884,714	10,535,473	4,230,760
1923	443,935	187,877	1,556,830	791,884	11,373,801	5,104,194
1924	381,832	184,534	1,242,836	661,271	9,211,285	4,311,733
1925	480,195	211,250	1,221,198	685,011	13,287,076	6,500,191

[1] Data not available.

Fish scrap and meal.—The total value of scrap and meal of all kinds produced in 1925 was $4,650,635, made up as follows: Dried scrap and meal, 69,733 tons, valued at $3,500,496; acidulated scrap, 41,773 tons, valued at $1,109,067; crude or green scrap, 5,477 tons, valued at $9,414; and shrimp bran, 1,079 tons, valued at $31,658. A large portion of the dried and acidulated scrap was produced in the menhaden industry, and the whaling industry also contributed largely to the dried-scrap production.

Comparative statistics of the production of scrap and meal from fish (including menhaden), whale, and shrimp

Year	Dried scrap and meal		Acidulated scrap		Crude or green scrap		Shrimp bran		Total
	Tons	*Value*	*Tons*	*Value*	*Tons*	*Value*	*Tons*	*Value*	*Value*
1921	60,031	$2,613,361	44,454	$895,140	2,160	$31,827	628	$16,814	$3,557,142
1922	89,459	3,755,787	25,712	555,973	433	9,519	562	15,398	4,336,677
1923	66,088	3,286,504	44,935	1,064,870	1,593	13,721	1,269	48,290	4,413,385
1924	51,855	2,370,237	24,963	504,639	3,543	6,262	936	31,580	2,912,718
1925	69,733	3,500,496	41,773	1,109,067	5,477	9,414	1,079	31,658	4,650,635

Fish glue.—In 1925, the production of fish glue was 510,816 gallons, valued at $589,064. The production of this commodity has increased appreciably, as may be seen from the following figures on the production for the last five years:

Year	Gallons	Value	Year	Gallons	Value
1921	347,048	$364,415	1924	502,940	$550,391
1922	323,003	278,424	1925	510,816	589,064
1923	465,814	680,054			

Shell by-products.—In 1925 there were produced 226,971 tons of crushed oyster shell for poultry grit, valued at $2,075,057; 67,818 tons of oyster-shell lime, valued at $303,261; and 360 tons of crushed marine clam shells, valued at $4,413; a total of 295,149 tons of shell products, valued at $2,382,731.

Production of shell products, 1925

Products	Connecticut, Rhode Island, and New York		New Jersey and Pennsylvania		Maryland		Virginia		North Carolina, South Carolina, and Georgia	
	Tons	*Value*	*Tons*	*Value*	*Tons*	*Value*	*Tons*	*Value*	*Tons*	*Value*
Crushed oyster shell:										
Poultry grit	1,697	$21,712	9,667	$114,541	63,709	$643,889	24,872	$264,705	7,307	$79,763
Lime	466	2,073	3,242	15,388	27,488	76,747	27,134	188,475	1,565	10,308
Total	2,163	23,785	12,909	129,929	91,197	720,636	52,006	453,180	8,872	90,071

Products	Florida and Alabama		Mississippi		Louisiana		Texas		Total	
	Tons	*Value*	*Tons*	*Value*	*Tons*	*Value*	*Tons*	*Value*	*Tons*	*Value*
Crushed oyster shell:										
Poultry grit	11,752	$97,593	32,283	$288,845	71,384	$526,834	4,300	$37,175	226,971	$2,075,057
Lime	1,730	2,078	1,548	1,172	4,145	5,670	500	1,350	67,818	303,261
Total	13,482	99,671	33,831	290,017	75,529	532,504	4,800	38,525	294,789	2,378,318

NOTE.—In addition to the above, there were produced elsewhere 360 tons of crushed marine clam shells, valued at $4,413.

Comparative statistics of oyster shell by-products, 1921 to 1925

Year	Crushed oyster shell		Oyster-shell lime		Total
	Tons	*Value*	*Tons*	*Value*	*Value*
1921	185,474	$1,759,120	73,764	$502,634	$2,261,754
1922	236,021	2,005,838	93,168	431,213	2,437,051
1923	224,983	1,986,249	83,808	372,286	2,358,535
1924	219,211	2,019,254	70,269	336,384	2,355,638
1925	226,971	2,075,057	67,818	303,261	2,378,318

Menhaden industry.—The menhaden industry recovered to some extent from the slump it experienced in 1924, its production in 1925 being as follows: Dried scrap and meal, 30,167 tons, valued at $1,519,458; acidulated scrap, 41,463 tons, valued at $1,102,051; oil, 6,023,108 gallons, valued at $3,001,106; a total of $5,622,615 worth of products.

Products of the menhaden industry, 1925

Products	Connecticut, New York, and New Jersey		Delaware		Virginia	
	Quantity	*Value*	*Quantity*	*Value*	*Quantity*	*Value*
Fish utilized: Menhaden, number	113,544,000		78,619,000		246,083,000	
Products:						
Dry scrap and meal, tons	821	$36,945			18,049	$939,585
Acidulated scrap, do	10,822	283,942	7,541	$213,884		
Oil, gallons	1,018,179	516,171	853,470	427,650	2,646,780	1,319,695
Total		837,058		641,534		2,259,280

Products	North Carolina		Georgia, Florida, and Texas		Total	
	Quantity	*Value*	*Quantity*	*Value*	*Quantity*	*Value*
Fish utilized: Menhaden, number	210,871,000		145,089,000		[1] 794,206,000	
Products:						
Dry scrap and meal, tons	5,526	$266,055	5,771	$276,873	[2] 30,167	$1,519,458
Acidulated scrap, do	17,600	455,725	5,500	148,500	41,463	1,102,051
Oil, gallons	1,137,694	570,011	366,985	167,579	6,023,108	3,001,106
Total		1,291,791		592,952		5,622,615

[1] 476,524,000 pounds.
[2] Of this quantity, 4,280 tons, valued at $256,910, were reported as fish meal.

Comparative statistics of the products of the menhaden industry, 1921 to 1925

Year	Dried scrap and meal		Acidulated scrap		Oil		Total
	Tons	*Value*	*Tons*	*Value*	*Gallons*	*Value*	*Value*
1921	37,858	$1,380,455	44,804	$905,640	6,260,478	$1,719,892	$4,005,987
1922	67,821	2,665,441	25,755	556,317	7,102,677	2,904,833	6,126,591
1923	43,452	2,029,406	44,935	1,064,870	7,461,365	3,316,277	6,410,553
1924	21,008	996,866	24,409	495,684	3,923,904	1,817,626	3,310,176
1925	30,167	1,519,458	41,463	1,102,051	6,023,108	3,001,106	5,622,615

FOREIGN FISHERY TRADE

The foreign trade in fishery products of the United States during 1925 amounted to $70,293,363, of which $49,030,591 were the value of fishery products imported for consumption and $21,262,772 the value of exports of domestic fishery products. The imports consisted of 263,330,035 pounds of edible fishery products valued at $29,059,225 and nonedible products valued at $19,971,366, while the exports consisted mainly of edible products amounting to 160,859,863 pounds, valued at $20,734,584, and nonedible products valued at $528,188.

Imports of edible fishery products consisted mainly of fresh and frozen fish that originated chiefly in Canada and Mexico, and of salted, dried, smoked, and pickled fish. Canned fish followed next and consisted principally of canned sardines. The remaining imports were of canned or fresh shellfish and other products, such as fish roe and caviar. Imports of nonedible fishery products consisted mainly of fish and marine animal oils, pearls and imitation pearl beads, shells, sponges, and agar agar, given in order of importance.

Exports consisted almost entirely of canned edible fishery products, mainly canned sardines and salmon, with other products in much smaller quantities. The Philippine Islands received 20.1 per cent of the canned sardines; Straits Settlements, 19.6 per cent; Argentina, 13.8 per cent; Dutch East Indies, 8.8 per cent; and Mexico 3.8 per cent. The United Kingdom purchased 46.7 per cent of the canned salmon; Philippine Islands, 13.9 per cent; Canada, 4.7 per cent; Mexico, 3.7 per cent; and Belgium, 1.8 per cent. Exports of nonedible fishery products consisted solely of shell and pearl buttons, unmanufactured shells, sponges, and fish oils.

The ratio of imports to exports of the quantity of fresh and frozen fish is 95 to 10; salted, dried, smoked, and pickled, 54 to 10; fish canned or packed in oil, 10 to 43; shellfish canned or fresh, 21 to 10; and other fish products, 10 to 13. The most striking feature of a digest of import and export statistics is the fact that while the United States produces about 40,000,000 pounds of fish and marine animal oils annually, this amount seems insufficient to supply the demand. As a consequence the imports of these products are 123 times greater than the exports. At the same time large quantities of waste fish and offal from the fishing industry continue to be available as a source of oil that possibly could be diverted to this trade.

Following are tables showing the amount and value of the foreign trade in fishery products by the United States for 1924 and 1925 and a comparison table for 1925.

Imports for consumption and domestic exports of fishery products, 1925, and ratio comparisons

Item	Imports		Exports		Ratio of imports to exports	
	Pounds	*Value*	*Pounds*	*Value*	*Quantity*	*Value*
Edible fishery products:						
Fish, fresh, frozen, or packed in ice	100,066,962	$7,763,320	10,516,636	$1,164,121	95:10	67:10
Fish, salted, dried, smoked, or pickled[2]	112,543,769	9,780,799	20,724,350	2,921,704	54:10	33:10
Fish, canned or packed in oil	27,472,262	4,958,763	118,249,718	14,666,544	10:43	10:30
Shellfish, canned or fresh	22,834,758	6,171,677	10,846,588	1,871,772	21:10	33:10
Other fish products, roe, caviar, etc	412,284	384,666	522,571	110,443	10:13	35:10
Total	263,330,035	29,059,225	160,859,863	20,734,584	16:10	14:10
Nonedible fishery products:						
Fish and marine animal oils[1]	75,746,068	6,716,223	614,274	115,078	1,230:10	584:10
All others		13,255,143		413,110		321:10
Total		19,971,366		528,188		378:10
Grand total		49,030,591		21,262,772		23:10

[1] Gallon of fish or marine animal oil calculated at 7.5 pounds.

Exports of domestic fishery products, 1924 and 1925

Item	1924		1925	
	Quantity	*Value*	*Quantity*	*Value*
Fish, fresh, frozen, or packed in ice:				
Salmon pounds	3,633,798	$503,255	4,233,549	$502,007
Other fresh fish do	9,833,859	1,036,695	6,283,087	662,114
Total do	13,467,657	1,539,950	10,516,636	1,164,121
Fish, salted, dried, smoked:				
Cod do	4,118,121	472,875	4,381,744	537,815
Haddock, hake, and pollock do	2,660,160	196,211	3,163,658	277,948
Herring do	2,113,582	114,792	3,442,340	212,331
Salmon, smoked or dry-cured do	1,829,503	393,429	1,650,740	341,106
Other do	2,699,974	197,158	1,716,468	132,875
Total do	13,421,340	1,374,465	14,354,950	1,502,075
Fish, pickled:				
Salmon do	5,365,400	1,298,371	4,748,600	1,293,941
Other do	1,763,000	133,593	1,620,800	125,688
Total do	7,128,400	1,431,964	6,369,400	1,419,629
Fish, canned:				
Salmon do	67,013,369	9,667,126	53,293,716	9,061,578
Sardines do	51,260,836	4,278,547	62,754,826	5,301,178
Tuna do	138,787	42,927		
Other do	2,148,323	214,977	2,201,176	303,788
Total do	120,561,315	14,203,577	118,249,718	14,666,544
Shellfish:				
Oysters, canned or fresh do	5,267,564	631,760		
Canned do			4,084,907	939,486
Not canned do			6,761,681	932,286
Other shellfish do	4,079,368	1,025,358		
Total do	9,346,932	1,657,118	10,846,588	1,871,772
Other fish products do	590,066	113,068	522,571	110,443
Total edible products do	164,515,710	20,320,142	160,859,863	20,734,584
Fish oils do	870,887	130,864	614,274	115,078
Buttons, pearl or shell gross	428,993	141,325	408,774	193,772
Shells, unmanufactured pounds	935,383	82,269	1,326,064	97,240
Sponges do	175,029	175,346	98,055	122,098
Total		398,940		413,110
Total nonedible products		529,804		528,188
Grand total		20,849,946		21,262,772

Imports of fishery products entered for consumption, 1924 and 1925

Item	1924		1925	
	Quantity	Value	Quantity	Value
Edible fishery products:				
Fish, fresh, frozen, or packed in ice—				
Cod, haddock, hake, and pollock ..... pounds	874,583	$47,047	1,238,452	$61,940
Eels ..... do	589,069	63,216	798,570	113,910
Fresh-water fishes ..... do	41,573,994	3,329,836	40,358,560	3,720,236
Halibut ..... do	5,029,659	653,299	3,740,015	465,035
Herring ..... do	1,195,592	62,199	2,386,842	121,676
Herring (fresh sea) ..... do	19,063,632	275,134	16,335,323	213,764
Mackerel ..... do	6,595,775	485,341	4,404,097	302,204
Salmon ..... do	8,327,010	949,226	6,459,167	740,433
Smelts ..... do	6,783,884	981,544	6,669,087	877,924
Swordfish ..... do	619,194	112,384	492,151	78,386
Tuna ..... do	5,033,421	220,172	10,444,220	491,318
Other dutiable ..... do	14,353,459	1,072,332	6,740,478	576,494
Total ..... do	110,039,272	8,251,730	100,066,962	7,763,320
Fish, salted, dried, smoked, or pickled—				
Cod, dried ..... do	27,580,514	2,258,335	26,862,736	2,454,238
Finnan haddie ..... do	1,232,405	114,242	936,353	80,820
Hake and pollock, dried ..... do	623,513	40,082	698,956	46,479
Herring, dried or smoked ..... do	850,483	52,905	1,107,542	69,683
Herring, pickled or salted ..... do	47,156,537	2,901,004	35,590,438	2,434,667
Herring, smoked, skinned, or boned ..... do	355,618	44,214	561,877	61,928
Mackerel, pickled or salted ..... do	11,209,528	984,277	13,494,366	1,044,118
Salmon, dried ..... do	3,944	861	6,661	1,267
Salmon, kippered, smoked, salted, pickled, or otherwise prepared ..... pounds	1,669,907	277,905	1,137,151	166,407
Other kippered, smoked, salted, pickled, or otherwise prepared fish not elsewhere specified ..... pounds	2,851,362	324,403	3,376,852	396,809
Other dried fish ..... do	3,966,716	503,180	6,049,707	816,728
Others, in bulk or in packages ..... do	23,541,940	2,364,130	22,721,130	2,207,655
Total ..... do	121,042,467	9,865,538	112,543,769	9,780,799
Fish packed in oil or other substances—				
Sardines ..... do	25,617,491	4,255,689	20,180,843	3,590,012
All others ..... do	8,630,332	1,593,987	7,291,419	1,368,751
Total ..... do	34,247,823	5,849,676	27,472,262	4,958,763
Fish roe, frozen, prepared, or preserved—				
Caviar ..... do	259,304	350,233	158,734	322,428
Other fish roe, preserved ..... do	252,670	60,682	253,550	62,238
Total ..... do	511,974	410,915	412,284	384,666
Shellfish—				
Crabs ..... do	156,829	11,011	34,601	3,105
Crab meat packed in ice, frozen, or otherwise prepared or preserved ..... pounds	5,167,087	1,781,412	8,332,699	2,818,299
Lobsters, canned ..... do	1,747,990	906,745	1,382,513	819,048
Lobsters, fresh, frozen, packed in ice or prepared or preserved in any manner (not specially provided for) ..... pounds	4,985,583	1,178,424	6,998,997	1,585,843
Turtles ..... do	694,811	46,641	643,315	40,391
Other shellfish and shrimp ..... do	6,270,767	974,647	5,442,633	904,991
Total ..... do	19,023,067	4,898,880	22,834,758	6,171,677
Total edible fishery products ..... do	284,864,603	29,276,739	263,330,035	29,059,225

Imports of fishery products entered for consumption, 1924 and 1925—Continued

Item	1924		1925	
	Quantity	Value	Quantity	Value
Nonedible fishery products:				
Fish and marine animal oils—				
Cod oil—gallons	1,915,657	$940,762	1,755,070	$864,131
Cod-liver oil—do	930,931	631,546	1,220,440	1,055,914
Herring, menhaden, and sod oil—do	601,406	206,688	567,236	238,468
Other fish oils—do	149,673	46,916	125,798	41,578
Seal oil—do	483,985	221,030	364,893	187,718
Whale oil, sperm—do	70,492	37,538	258,261	103,863
Whale oil, other—do	5,003,779	2,477,787	7,141,111	4,224,551
Total—do	9,155,923	4,562,267	11,432,809	6,716,223
Pearls and imitation pearl—				
Pearls and parts, not strung or set—number	679,484	5,898,560	2,052,518	6,734,149
Imitation half pearls and hollow or filled pearl without holes or with holes partly through—number	7,774,886	220,825	9,139,307	198,107
Imitation solid pearls, wholly or partly pierced, mounted or unmounted—number	10,727,426	74,926	1,408,156	24,541
Imitation pearl beads—pounds	1,194,623	2,269,820	1,613,044	2,169,251
Total		8,464,131		9,126,048
Shells and buttons of pearl or shell—				
Shells, not manufactured—				
Green snail shell—do	501,096	73,644	260,588	26,688
Mother-of-pearl—do	7,394,529	1,836,942	5,484,394	1,707,817
All others—do	1,128,999	239,521	1,116,934	194,186
Shells, manufactured—do	183,174	96,867	118,268	119,505
Shell or pearl buttons—				
Fresh-water—gross	23,251	7,181	20,600	7,057
Ocean or trochus—do	228,134	71,175	242,623	83,670
Button blanks, not turned, faced, or drilled—gross	4,306	6,468	1,934	1,135
Button blanks, not turned, faced, or drilled (from Philippine Islands)—gross	1,023,228	411,496	722,223	316,466
Total		2,743,294		2,456,524
Sponges—pounds	657,831	266,998	232,969	241,213
Sponges (from Cuba)—do	631,343	444,539	663,302	644,671
Sponges (from Philippine Islands)—do	571	1,248	2,586	5,628
Sponges, manufactures of, not specially provided for—pounds	4,788	5,806	471	1,818
Sponges, manufactures of, not specially provided for (from Cuba)—pounds	827	1,291	694	1,178
Total—do	1,295,360	719,882	900,022	894,508
Agar agar—do	404,640	403,391	501,226	461,947
Ambergris—do	107	29,376	223	80,365
Cuttle fish bone—do	282,389	38,778	308,441	46,663
Fish for purposes other than human consumption—pounds	1,134,925	23,907	2,491,645	80,499
Fish skins, raw or salted—do	250,202	6,295	226,892	7,378
Fish sounds, crude, dried, or salted for preservation only—pounds	159,126	41,266	151,854	42,263
Sea grass, eelgrass, and sea weed, dyed or manufactured—pounds	120,926	26,200	191,227	41,169
Sealskins—number	90	1,712	289	7,253
Whalebone, unmanufactured—pounds	2,675	1,502	18,945	10,037
Whalebone, manufactures of—do	167	626	220	489
Total		573,053		778,063
Total nonedible fishery products		17,062,627		19,971,366
Grand total		46,339,366		49,030,591

COLD-STORAGE HOLDINGS OF FROZEN FISH IN 1925

The statistics of the cold-storage holdings of frozen fish and the quantities of fish frozen are collected by the Bureau of Agricultural Economics, Department of Agriculture, and in 1925, as in previous years, were published monthly and distributed by the Bureau of Fisheries. This regular, monthly cold-storage bulletin usually is in the hands of the trade by the 20th of each month. To place the information at its disposal earlier, a comprehensive preliminary release is issued on the first of each month, showing the holdings of fish for the current month, the holdings for the corresponding month a year previous, and the amount frozen during the current month for 14 of the important commercial species.

During 1925 there were 177 freezers and cold-storage establishments devoted wholly or in part to the storage of frozen fish. The holdings were somewhat less than during the previous year, varying between 22,441,873 pounds in the month of April and 61,849,359 pounds in the month of November. The average monthly holdings during the year amounted to 44,084,251 pounds, as compared with 45,040,533 pounds in 1924, a decrease of 2.13 per cent. Compared with the 5-year average, the monthly holdings in 1925 were rather larger, being 6.55 per cent above the 5-year average. The holdings during the first seven months of 1925 were 1 to 18 per cent larger than in the same months the previous year, and during the last five months they were 2 to 15 per cent smaller. Compared with the 5-year average, they were 7 to 27 per cent higher during the first nine months and 2 to 5 per cent lower during the last three months of 1925.

Comparative statement of cold-storage holdings of frozen fish in 1925 and 1924, and the 5-year average

Month	1925	1924	Five-year average	Increase (+) or decrease (−)	
				Compared with 1924	Compared with 5-year average
	Pounds	*Pounds*	*Pounds*	*Per cent*	*Per cent*
January	55,307,587	52,627,290	51,267,000	+5.09	+7.88
February	44,034,450	40,420,614	39,053,000	+8.94	+12.75
March	29,864,613	29,570,628	27,027,000	+.99	+10.49
April	22,441,873	21,488,525	19,728,000	+4.44	+13.75
May	23,749,277	21,839,714	19,477,000	+8.74	+21.93
June	31,979,574	27,115,359	25,161,000	+17.93	+27.10
July	40,458,169	36,036,010	33,132,000	+12.27	+22.11
August	47,473,515	49,026,140	42,984,000	−3.17	+10.44
September	55,446,548	56,606,759	52,347,000	−2.05	+5.92
October	58,357,764	67,024,996	61,607,000	−12.94	−5.28
November	61,849,359	70,405,786	63,429,000	−12.16	−2.49
December	58,048,280	68,324,572	61,255,000	−15.05	−5.24
Average for year	44,084,251	45,040,533	41,372,000	−2.13	+6.55

Holdings of frozen fish in the United States in 1925, by species, and a 5-year average, 1920 to 1924

Species	Month ended—					
	Jan. 15	Feb. 15	Mar. 15	Apr. 15	May 15	June 15
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Bluefish (all trade sizes)	287,873	196,732	67,264	32,193	48,655	59,715
Butterfish (all trade sizes)	480,051	365,363	253,329	94,848	43,106	154,945
Catfish	172,927	101,070	44,661	38,352	124,441	131,846
Ciscoes (including bluefin, blackfin, chub, lake herring, etc.)	7,623,852	5,830,439	3,887,880	2,067,075	1,315,934	1,008,139
Ciscoes (tullibees)	853,357	802,336	985,698	1,046,781	969,132	883,460
Cod, haddock, hake, pollock	795,276	605,187	509,747	651,339	796,798	804,987
Croaker	129,765	89,766	19,123	3,754	440,435	478,656
Flounders	336,226	245,819	248,923	274,889	489,348	608,082
Halibut (all trade sizes)	8,507,465	5,740,740	4,108,588	4,402,656	5,179,520	7,206,590
Herring, sea (including alewives and bluebacks)	3,776,670	3,827,486	2,132,352	828,312	785,586	819,447
Lake trout	1,610,461	1,235,694	773,277	410,344	417,885	556,574
Mackerel (except Spanish)	3,241,991	2,483,916	1,553,862	854,320	711,726	2,456,607
Pike perches and pike or pickerel	1,324,993	1,016,647	618,509	324,360	722,773	1,199,810
Sablefish (black cod)	1,038,382	678,031	872,163	592,085	568,261	224,954
Salmon, silver and fall	4,126,643	3,476,931	1,940,826	1,097,303	846,995	1,184,307
Salmon, steelhead trout	310,609	267,091	247,745	174,789	96,966	103,492
Salmon, all other	4,886,949	3,948,546	2,022,251	2,836,151	2,617,159	2,908,282
Scup (porgies)	65,835	24,076	10,047	3,679	80,074	401,133
Shad and shad roe	713,394	739,288	522,909	474,252	611,105	762,217
Shellfish	1,278,772	1,227,341	1,018,057	702,089	656,750	667,756
Smelts, eulachon, etc	522,242	503,278	747,700	862,171	779,707	765,386
Squeteagues or "sea trout"	306,138	164,144	33,315	13,214	152,634	263,473
Squid	1,532,879	1,238,888	840,105	199,876	574,235	1,764,218
Sturgeon and spoonbill cat	497,454	466,696	303,490	244,440	273,737	306,296
Suckers	42,107	40,059	49,993	31,448	29,983	32,458
Whitefish	1,951,795	1,745,562	1,743,448	1,294,723	1,224,435	1,132,629
Whiting	2,780,416	2,296,944	1,334,682	827,252	848,234	2,033,689
Miscellaneous frozen fish	6,113,065	4,676,380	2,974,669	2,059,178	2,343,723	3,060,426
Total, 1925	55,307,587	44,034,450	29,864,613	22,441,873	23,749,277	31,979,574
Five-year average, 1920–1924	51,268,223	39,050,563	27,026,197	19,727,173	19,475,490	25,161,374

Species	Month ended—					
	July 15	Aug. 15	Sept. 15	Oct. 15	Nov. 15	Dec. 15
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Bluefish (all trade sizes)	135,699	95,285	103,139	335,288	474,565	547,724
Butterfish (all trade sizes)	275,866	387,932	715,684	1,294,183	1,247,847	1,056,582
Catfish	151,328	111,904	110,507	95,055	105,863	82,448
Ciscoes (including bluefin, blackfin, chub, lake herring, etc.)	746,398	833,540	684,706	539,609	1,541,644	3,180,117
Ciscoes (tullibees)	853,362	824,855	764,274	573,041	510,488	451,232
Cod, haddock, hake, pollock	820,537	926,122	1,582,536	1,564,557	1,523,124	1,104,155
Croaker	1,118,090	1,218,590	1,111,570	866,730	775,331	534,764
Flounders	691,281	745,878	824,185	775,410	710,311	647,035
Halibut (all trades sizes)	8,448,458	9,752,570	10,616,852	10,995,236	9,400,480	7,038,674
Herring, sea (including alewives and bluebacks)	1,109,606	991,553	2,018,314	2,481,383	2,951,672	3,253,802
Lake trout	746,417	819,352	840,348	987,468	1,850,380	2,143,548
Mackerel (except Spanish)	2,880,270	4,596,567	6,867,043	7,643,432	6,910,402	5,342,937
Pike perches and pike or pickerel	1,000,495	825,002	716,983	863,897	2,952,476	3,842,287
Sablefish (black cod)	532,061	851,587	1,082,614	1,601,240	2,145,559	2,153,802
Salmon, silver and fall	1,558,764	2,142,690	2,462,339	3,210,257	3,840,903	3,379,724
Salmon, steelhead trout	331,904	654,497	652,261	841,464	730,774	644,580
Salmon, all other	3,569,736	4,464,728	5,133,344	5,360,481	5,036,230	4,257,296
Scup (porgies)	667,853	736,385	699,321	672,325	544,926	419,557
Shad and shad roe	763,710	749,935	687,870	734,651	702,123	672,014
Shellfish	637,127	733,080	795,964	927,355	1,081,106	1,267,692
Smelts, eulachon, etc	717,405	568,334	583,681	578,451	582,812	650,393
Squeteagues or "sea trout"	366,233	481,108	1,029,771	1,638,534	1,615,814	1,296,381
Squid	2,028,068	2,110,170	2,034,939	2,079,704	1,870,558	1,597,404
Sturgeon and spoonbill cat	365,510	444,625	408,970	403,623	376,572	298,560
Suckers	30,837	32,906	34,282	36,467	43,792	51,104
Whitefish	1,282,559	1,373,567	1,393,188	1,327,803	1,907,364	2,315,779
Whiting	5,208,604	7,065,724	7,022,677	6,700,948	6,773,678	6,144,851
Miscellaneous frozen fish	3,419,991	2,935,029	4,469,186	3,229,172	3,642,565	3,673,838
Total, 1925	40,458,169	47,473,515	55,446,548	58,357,764	61,849,359	58,048,280
Five-year average, 1920–1924	33,134,173	42,984,862	52,346,655	61,605,504	63,428,602	61,254,199

QUANTITIES OF FISH FROZEN IN 1925

During the year ended December 15, 1925, 91,165,068 pounds of fish were frozen, as compared with 97,324,144 pounds in 1924, a decrease of 6.3 per cent. The principal species frozen during the year were salmon (including steelhead trout), 12,153,515 pounds; halibut, 12,041,155 pounds; whiting, 10,152,799 pounds; mackerel, 8,948,297 pounds; ciscoes (including tullibees), 5,581,273 pounds; herring, 5,264,269 pounds; and pike perch, pike, or pickerel, 5,233,655 pounds. The smallest amount frozen during any one month was 2,193,421 pounds, or 2.41 per cent of the total, in February; the largest amount frozen during any one month was 11,717,710 pounds, or 12.85 per cent of the total, in November. The following tables give the statistics of the quantities of fish frozen during the year 1925:

Fish frozen monthly in 1925, by species, and in 1920–1924, by totals[1]

Species	Month ended—						
	Jan. 15	Feb. 15	Mar. 15	Apr. 15	May 15	June 15	July 15
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Bluefish (all trade sizes)	94,746	600	14,493	3,810	11,082	12,512	41,705
Butterfish (all trade sizes)	7,320			1,781	8,327	146,666	141,856
Catfish	6,454	1,577	7,734	11,127	98,698	38,594	50,563
Ciscoes (including bluefin, blackfin, chub, lake herring, etc.)	1,026,651	90,562	42,969	149,517	76,309	94,422	63,018
Ciscoes (tullibees)	185,599	91,457	110,312	55,955	36,000	246	2,618
Cod, haddock, hake, pollock	134,607	113,170	175,122	326,679	315,094	122,485	105,106
Croakers	2,100		414	1,500	411,470	69,399	395,532
Flounders	57,168	21,492	37,633	85,394	211,581	206,834	117,072
Halibut (all trade sizes)	453,098	121,227	1,533,414	1,339,498	869,324	1,923,334	1,344,419
Herring, sea (including alewives and bluebacks)	150,625	421,342	224,231	9,096	375,773	244,624	492,886
Lake trout	217,945	50,653	29,884	12,862	63,460	107,333	142,065
Mackerel (except Spanish)	90,220	26,640	48,167	72,251	101,734	1,916,341	648,501
Pike perches and pike or pickerel	321,847	76,174	126,076	65,421	574,547	477,060	59,218
Sablefish (black cod)	72,992	19,359	54,399	8,718	85,920	39,786	387,501
Salmon, silver and fall	154,958	16,651	68,967	45,636	141,587	332,156	446,572
Salmon, steelhead trout		23,160	7,600	16,675	2,933	19,670	237,511
Salmon, all other	42,896	10,314	74,452	1,288,787	87,811	588,269	1,040,399
Scup (porgies)					78,885	338,838	353,375
Shad and shad roe	620	1,724	3,540	21,506	91,494	204,954	17,865
Shellfish	236,627	117,497	101,149	82,051	191,345	143,401	174,639
Smelts, eulachon, etc	83,747	34,296	42,493	39,366	8,918	22,602	505
Squeteagues or "sea trout"	2,601				142,615	131,430	38,001
Squid		287	49,120	540	499,790	1,277,225	375,289
Sturgeon and spoonbill cat	19,865	6,579	14,624	14,553	71,215	62,226	107,540
Suckers	7,635	2,335	26,850	973	464	3,178	223
Whitefish	79,583	103,834	295,701	186,489	88,131	65,338	139,987
Whiting	12,119	410,386	178,199	74,460	299,991	1,410,344	3,657,351
Miscellaneous frozen fish	470,530	432,105	220,280	400,236	913,059	800,653	640,058
Total frozen fish, 1925	3,932,553	2,193,421	3,487,823	4,314,881	5,857,557	10,799,920	11,221,375
Total frozen fish, 1924	3,179,098	2,440,163	2,417,473	2,729,366	6,040,261	8,281,516	11,996,011
Total frozen fish, 1923	2,741,538	1,662,135	1,412,490	1,400,078	5,026,888	7,671,127	11,871,645
Total frozen fish, 1922	2,441,892	1,452,801	1,363,942	1,496,538	1,980,435	5,849,537	7,376,237
Total frozen fish, 1921	4,005,000	2,843,000	1,770,000	2,413,000	2,698,000	9,624,000	10,151,000
Total frozen fish, 1920	2,291,082	2,273,744	2,630,482	2,465,375	3,687,538	10,094,367	12,761,791

[1] These figures have been revised in accordance with further reports received since original publication of data for the month.

Fish frozen monthly in 1925, by species, and in 1920–1924, by totals—Contd.

Species	Month ended— Aug. 15	Sept. 15	Oct. 15	Nov. 15	Dec. 15	Total	Per cent of total
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	
Bluefish (all trade sizes)	16,638	28,708	267,703	74,196	3,110	569,303	0.62
Butterfish (all trade sizes)	113,372	312,835	640,238	94,069	53,184	1,519,648	1.67
Catfish	3,377	5,861	8,587	31,380	7,627	271,579	.30
Ciscoes (including bluefin, blackfin, chub, lake herring, etc.)	162,156	66,161	44,388	1,091,342	1,845,344	4,752,839	5.21
Ciscoes (tullibees)	8,810	9,634	182,063	74,192	71,548	828,434	.91
Cod, haddock, hake, pollock	179,369	631,744	226,930	330,472	120,641	2,781,419	3.05
Croakers	157,523	122,773	2,442	53,899	4,436	1,221,488	1.34
Flounders	109,843	120,000	30,359	47,527	78,504	1,123,407	1.23
Halibut (all trade sizes)	1,432,984	1,419,346	729,794	395,244	479,473	12,041,155	13.21
Herring, sea (including alewives and bluebacks)	158,145	1,017,650	706,028	959,502	504,367	5,264,269	5.77
Lake trout	138,145	112,811	209,140	790,488	180,995	2,055,781	2.26
Mackerel (except Spanish)	1,989,476	2,472,091	952,611	491,849	228,416	8,948,297	9.82
Pike perches and pike or pickerel	99,413	99,584	230,277	2,187,898	916,140	5,233,655	5.74
Sablefish (black cod)	347,438	274,830	625,904	557,624	144,575	2,619,046	2.87
Salmon, silver and fall	777,276	436,788	949,721	966,997	211,148	4,548,457	4.99
Salmon, steelhead trout	610,097	373,104	128,974	33,621	28,033	1,481,378	1.62
Salmon, all other	1,057,206	812,276	517,354	515,532	88,384	6,123,680	6.72
Scup (porgies)	112,047	2,148	12,612	123	1,500	899,528	.99
Shad and shad roe	4,587	137	133	2,187	2,500	351,247	.39
Shellfish	221,882	278,222	324,423	311,678	273,704	2,456,618	2.69
Smelts, eulachon, etc	4,380	21,288	18,359	47,988	26,738	350,680	.38
Squeteagues or "sea trout"	149,443	465,966	650,306	66,415	650	1,647,427	1.81
Squid	216,097	211,870	220,497	65,909	98,769	3,015,393	3.31
Sturgeon and spoonbill cat	100,761	67,699	85,917	50,722	2,408	604,109	.66
Suckers	2,455	2,847	2,962	8,276	12,801	70,999	.08
Whitefish	45,874	42,772	11,032	642,339	155,918	1,856,998	2.04
Whiting	2,223,927	268,757	253,495	973,701	390,069	10,152,779	11.13
Miscellaneous frozen fish	459,266	1,916,761	560,782	942,540	619,165	8,375,435	9.19
Total frozen fish, 1925	10,901,987	11,594,663	8,593,031	11,717,710	6,550,147	91,165,068	100.00
Total frozen fish, 1924	15,541,641	10,585,272	14,877,934	10,854,873	8,380,536	97,324,144	
Total frozen fish, 1923	13,943,978	16,417,132	12,511,606	6,951,639	9,938,387	91,548,643	
Total frozen fish, 1922	9,121,160	10,826,942	16,830,080	9,344,469	7,069,995	75,154,028	
Total frozen fish, 1921	9,845,000	9,356,000	9,990,000	9,869,000	8,173,000	80,737,000	
Total frozen fish, 1920	13,620,232	11,803,606	11,168,810	9,711,800	9,750,844	92,259,671	

Fish frozen in 1925, by geographical sections[1]

BY MONTHS

Month ended the 15th of—	New England	Middle Atlantic	South Atlantic	North Central, East
	Pounds	*Pounds*	*Pounds*	*Pounds*
January	203,523	1,180,883	20,778	1,685,205
February	305,352	284,905	15,780	344,941
March	153,001	281,922	14,350	911,939
April	460,556	339,903	13,850	605,821
May	1,307,604	1,842,571	147,466	860,186
June	3,659,546	3,191,453	71,630	557,356
July	4,870,932	1,590,684	190,208	385,089
August	4,662,590	1,075,488	163,121	366,714
September	4,203,276	1,717,800	275,070	298,216
October	2,121,635	2,392,983	109,936	474,231
November	1,838,686	3,945,272	76,578	2,613,414
December	774,297	1,072,256	38,411	2,771,552
Total	24,560,998	18,916,120	1,137,178	11,874,664
Per cent of total	26.94	20.75	1.25	13.03

[1] New England includes the 6 States of that section. Middle Atlantic: New York, New Jersey, and Pennsylvania. South Atlantic: Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, and Florida. North Central, East: Ohio, Indiana, Illinois, Michigan, and Wisconsin. North Central, West: Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, and Kansas. South Central and Mountain: Kentucky, Tennessee, Alabama, Mississippi, Louisiana, Texas, Oklahoma, Arkansas, Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, and Nevada. Pacific: Washington, Oregon, California, and Alaska.

Fish frozen in 1925, by geographical sections—Continued

BY MONTHS

Month ended the 15th of—	North Central, West	South Central and Mountain	Pacific	Total	Per cent
	Pounds	*Pounds*	*Pounds*	*Pounds*	
January	407,656	102,816	331,692	3,932,553	4.31
February	637,455	125,603	479,385	2,193,421	2.41
March	354,174	90,735	1,681,702	3,487,823	3.83
April	281,937	108,190	2,504,624	4,314,881	4.73
May	328,475	151,127	1,220,128	5,857,557	6.43
June	150,897	115,403	3,053,635	10,799,920	11.85
July	374,993	108,040	3,701,429	11,221,375	12.31
August	260,868	66,909	4,306,297	10,901,987	11.96
September	324,521	45,545	4,730,235	11,594,663	12.72
October	410,097	26,496	3,057,653	8,593,031	9.43
November	769,258	25,814	2,448,688	11,717,710	12.85
December	949,431	84,106	860,094	6,550,147	7.17
Total	5,249,762	1,050,784	28,375,562	91,165,068	100.0
Per cent of total	5.76	1.15	31.12		

BY SPECIES

Species	New England	Middle Atlantic	South Atlantic	North Central, East
	Pounds	*Pounds*	*Pounds*	*Pounds*
Bluefish (all trade sizes)	4,439	441,766		115,568
Butterfish (all trade sizes)	153,775	1,311,983	29,097	24,633
Catfish	19,135	8,688		53,761
Ciscoes (including bluefin, blackfin, chub, lake herring, etc.)	11,696	977,531		3,108,701
Ciscoes (tullibees)	25,445	219,431	14,220	401,751
Cod, haddock, hake, pollock	1,613,233	483,298	13,730	85,356
Croakers	414	804,806	346,123	70,145
Flounders	427,906	585,383		10,387
Halibut (all trade sizes)	419,904	323,368	4,828	1,329,191
Herring, sea (including alewives and bluebacks)	4,002,057	398,667	55,000	178,288
Lake trout	3,995	377,536		1,351,820
Mackerel (except Spanish)	6,526,800	1,547,301	12,250	140,841
Pike perches and pike or pickerel	2,795	3,124,869		1,935,443
Sablefish (black cod)		900		25,096
Salmon, silver and fall	183,314	153,871	100	222,083
Salmon, steelhead trout		18,581		817
Salmon, all other	341,183	137,454		238,847
Scup (porgies)	238,292	658,792		
Shad and shad roe	59,765	95,775		22,127
Shellfish	557,273	637,957	160,453	354,542
Smelts, eulachon, etc	69,672	26,247		128,441
Squeteagues or "sea trout"	140	1,518,600	128,037	
Squid	2,524,318	438,393		43,210
Sturgeon and spoonbill cat		359,641	3,100	24,470
Suckers		2,378		66,167
Whitefish	830	613,374		1,019,027
Whiting	6,452,962	1,952,967		18,319
Miscellaneous frozen fish	921,655	1,696,563	370,240	905,633
Total	24,560,998	18,916,120	1,137,178	11,874,664

Fish frozen in 1925, by geographical sections—Continued

BY SPECIES—Continued

Species	North Central, West	South Central and Mountain	Pacific	Total
	Pounds	*Pounds*	*Pounds*	*Pounds*
Bluefish (all trade sizes)	----------	7,530	----------	569,303
Butterfish (all trade sizes)	160	----------	----------	1,519,648
Catfish	175,742	14,253	----------	271,579
Ciscoes (including bluefin, blackfin, chub, lake herring, etc.)	636,286	18,625	----------	4,752,839
Ciscoes (tullibees)	105,673	2,312	59,602	828,434
Cod, haddock, hake, pollock	106,814	----------	478,988	2,781,419
Croakers	----------	----------	----------	1,221,488
Flounders	22	----------	99,709	1,123,407
Halibut (all trade sizes)	184,467	2,400	9,776,997	12,041,155
Herring, sea (including alewives and bluebacks)	249,987	2,151	378,119	5,264,269
Lake trout	287,653	4,085	30,692	2,055,781
Mackerel (except Spanish)	59,397	----------	661,708	8,948,297
Pike perches and pike or pickerel	165,848	75	4,625	5,233,655
Sablefish (black cod)	41,719	----------	2,551,331	2,619,046
Salmon, silver and fall	106,054	----------	3,883,035	4,548,457
Salmon, steelhead trout	----------	----------	1,461,980	1,481,378
Salmon, all other	49,272	30,066	5,326,858	6,123,680
Scup (porgies)	1,500	----------	944	899,528
Shad and shad roe	4,402	1,240	167,938	351,247
Shellfish	131,517	7,889	606,987	2,456,618
Smelts, eulachon, etc.	3,605	----------	122,715	350,680
Squeteagues or "sea trout"	----------	650	----------	1,647,427
Squid	9,185	----------	287	3,015,393
Sturgeon and spoonbill cat	----------	64,133	152,765	604,109
Suckers	2,454	----------	----------	70,999
Whitefish	217,513	3,894	2,360	1,856,998
Whiting	1,728,551	----------	----------	10,152,799
Miscellaneous frozen fish	981,941	891,481	2,607,922	8,375,435
Total	5,249,762	1,050,784	28,375,562	91,165,068

QUANTITIES OF FISH FROZEN IN 1924 AND 1925, COMPARED

In the following table the amounts of the various kinds of fish frozen in 1925 are compared with those of the previous year. Increases were recorded by 13 groups and decreases by 11. Cisco showed a decline from 13,195,023 pounds in 1924 to 5,581,273 pounds in 1925, a decrease of 57.7 per cent. This was the result of the unusually poor catch of that species of lake fish during the season 1925. On the other hand, the group of pike and pike perches, which are also lake fish, showed an increase from 3,200,624 pounds in 1924 to 5,233,655 pounds in 1925, or 63.5 per cent. Among the salt-water groups, salmon and halibut, while ranking first and second in amounts frozen, registered decreases of 15.1 and 17.8 per cent, respectively. Mackerel showed an increase of 64 per cent. The salt-water group that showed the greatest relative increase was the scup, which increased from 332,103 pounds in 1924 to 899,528 pounds in 1925, or 170.9 per cent.

Comparison of amounts of fish frozen in 1925 with those frozen in 1924

Group	1925	1924	Increase (+) or decrease (−)
	Pounds	*Pounds*	*Per cent*
Salmon (all species)	12, 153, 515	14, 309, 666	−15. 1
Halibut (all trade sizes)	12, 041, 155	14, 650, 787	−17. 8
Whiting	10, 152, 799	7, 528, 339	+34. 9
Mackerel (except Spanish)	8, 948, 297	5, 457, 676	+64
Cisco (all species)	5, 581, 273	13, 195, 023	−57. 7
Herring, sea (including alewives and bluefins)	5, 264, 269	8, 695, 698	−39. 5
Pike perches and pike or pickerel	5, 233, 655	3, 200, 624	+63. 5
Squid	3, 015, 393	3, 352, 552	−10. 1
Cod, haddock, hake, pollock	2, 781, 419	1, 862, 163	+49. 4
Sablefish (black cod)	2, 619, 046	2, 291, 306	+14. 3
Shellfish	2, 456, 618	2, 269, 045	+8. 3
Lake trout	2, 055, 781	2, 313, 784	−11. 2
Whitefish	1, 856, 998	1, 776, 045	+4. 6
Squeteagues or "sea trout"	1, 647, 427	648, 069	+154. 2
Butterfish (all trade sizes)	1, 519, 648	1, 131, 622	+34. 3
Croakers	1, 221, 488	804, 570	+51. 8
Flounders	1, 123, 407	808, 756	+38. 9
Scup (porgies)	899, 528	332, 103	+170. 9
Sturgeon and spoonbill cat	604, 109	787, 722	−23. 3
Bluefish (all trade sizes)	569, 303	412, 337	+38. 1
Shad and shad roe	351, 247	839, 974	−58. 2
Smelt, eulachon, etc	350, 680	483, 960	−27. 5
Catfish	271, 579	415, 025	−34. 6
Suckers	70, 999	79, 168	−10. 3
Miscellaneous	8, 375, 435	8, 827, 325	−5. 1
Total	91, 165, 068	97, 324, 144	−6. 3

NEW ENGLAND VESSEL FISHERIES

GENERAL STATISTICS

The vessel fisheries centering at Boston and Gloucester, Mass., and Portland, Me., were more productive in 1925 in the quantity of products than for any previous year for which statistics are available, and the value of the products was greater than for any year since 1918. There was an increase over 1924 of 12.43 per cent in the number of trips and of 18.54 per cent in the quantity and 16.05 per cent in the value of the products. The increase in the number of trips was at Boston and Gloucester, but there was an increase in the quantity and value of the products at each of the three ports. The increase in the number of trips at Boston was 17.91 per cent and at Gloucester 15.48 per cent, with a decrease at Portland of 4.66 per cent. The increase in products landed at Boston was 13.80 per cent in quantity and 13.01 per cent in value; at Gloucester, 38.01 per cent in quantity and 33.52 per cent in value; and at Portland, 13.78 per cent in quantity and 12.88 per cent in value. Statistics of the fisheries have been collected by the local agents and published in monthly bulletins, showing by species and fishing grounds the quantities and value of fishery products landed by American fishing vessels during the year at these ports. Two annual bulletins were issued, one showing the catch by months and the other by fishing grounds.

The fishing fleet at these ports during the calendar year 1925 numbered 347 sail, steam, and gasoline vessels, including 29 steam trawlers. These vessels landed at Boston 4,404 trips, aggregating 149,038,498 pounds of fish, valued at $6,104.278; at Gloucester, 2,491 trips, aggregating 49,471,943 pounds, valued at $1,390,580; and at

Portland, 1,509 trips, aggregating 18,358,824 pounds, valued at $620,712. The total for the three ports amounted to 8,404 trips, aggregating 216,869,265 pounds of fresh and salted fish, having a value to the fishermen of $8,115,570. In making these trips, including the date of departure and date of arrival, the vessels were absent from port 42,447 days. At Boston the trips landed occupied 27,762 days, at Gloucester 11,035 days, and at Portland 3,650 days.

Compared with the previous year, there was an increase of 929 trips, or 12.43 per cent, in the total number landed at Boston, Gloucester, and Portland, and an increase of 33,921,071 pounds, or 18.54 per cent, in quantity, and $1,122,618, or 16.05 per cent, in the value of the products landed. There was considerable increase in both the quantity and value of cod, haddock, and cusk, and a very large increase in the quantity and value of the catch of mackerel. There was a decrease in the catch of hake, halibut, herring, and swordfish. The quantity of pollock taken increased slightly, but the value decreased. The catch of cod increased 5,801,377 pounds, or 9.44 per cent, in quantity and $182,932, or 8.55 per cent, in value; haddock increased 11,984,485 pounds, or 15 per cent, in quantity and $439,136, or 19.02 per cent, in value; cusk increased 307,259 pounds, or 9.02 per cent, in quantity and $16,483, or 24.20 per cent, in value; and mackerel increased 16,452,351 pounds, or 168.61 per cent, in quantity and $649,368, or 119.86 per cent, in value. The catch of hake decreased 1,478,891 pounds, or 20.30 per cent, in quantity and $12,435, or 6.68 per cent, in value; pollock increased 204,595 pounds, or 4.02 per cent, in quantity and decreased $11,856, or 7.44 per cent, in value; halibut decreased 861,044 pounds, or 19.47 per cent, in quantity and $134,437, or 17.03 per cent, in value; and swordfish decreased 496,236 pounds, or 24.52 per cent, in quantity and $63,908, or 14.21 per cent, in value. The herring catch decreased 467,935 pounds, or 10.61 per cent, in quantity and $25,049, or 19.59 per cent, in value. The Newfoundland herring catch decreased from 2,943,480 pounds, valued at $108,371 in 1924, to 2,400,336 pounds, valued at $84,265 in 1925. In the various other species combined there was an increase of 2,475,110 pounds, or 47.52 per cent, in quantity and $82,384, or 36.90 per cent, in value.

The catch of scrod cod landed at these ports decreased from 318,440 pounds, valued at $5,371, in 1924, to 227,698 pounds, valued at $3,539, in 1925; and the catch of scrod haddock increased from 11,927,105 pounds, valued at $199,386, in 1924, to 14,571,900 pounds, valued at $299,393, in 1925. The small quantity of these grades landed, as compared with other grades of these species, is said to have been due to the fact that the price was so low that the fishermen did not save all that were caught. For several years there has been a decrease in the catch of scrod cod but an increase in the catch of scrod haddock.

The following tables present in detail, by fishing grounds and also by months, the fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American fishing vessels for the calendar year 1925. These include only the vessels of 5 net tons and upward, as measured by the United States Customs Service. The weights of fresh and salted fish given in these statistics represent the fish as landed from the vessels, and the values are those received by the fishermen. The grades, or sizes, given for certain species are those recognized in the trade.

Statement, by fishing grounds, of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American fishing vessels, 1925

Fishing grounds	Trips	Days absent	Cod							
			Large (10 pounds and over)				Market (under 10 and over 2½ pounds)			
			Fresh		Salted		Fresh		Salted	
LANDED AT BOSTON										
East of 66° W. longitude:			*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
La Have Bank	73	972	1,241,505	$60,195			461,235	$14,401		
Western Bank	95	1,345	1,477,480	65,926			571,195	15,336		
Quereau Bank	18	441	12,780	407			2,165	55		
Green Bank	1	29								
Grand Bank	5	96	10,900	533						
St. Peters Bank	3	51								
Burgeo Bank	2	57								
Cape Shore	58	860	122,975	5,467			70,680	1,926		
Gulf of St. Lawrence	2	52								
The Gully	7	139								
West of 66° W. longitude:										
Browns Bank	209	2,028	3,302,504	147,620			1,905,662	55,083		
Georges Bank	645	6,530	12,075,686	465,461	16,250	$721	2,722,630	81,424		
Cashes Bank	12	61	125,190	5,051			41,215	1,061		
Fippenies Bank	4	21	26,500	1,625			15,180	498		
Middle Bank	239	744	207,125	13,117			93,930	3,974		
German Bank	1	12	8,200	246			12,500	313		
Jeffreys Ledge	330	1,149	327,295	21,510			139,620	5,466		
South Channel	969	5,771	6,064,930	278,675			2,345,006	76,528		
Nantucket Shoals	180	1,309	687,910	33,576			541,260	16,081		
Off Chatham	322	1,059	234,238	10,745			128,760	4,845		
Seal Island	2	23	20,850	1,109			23,600	550		
Shore, general	1,227	5,013	632,672	29,806			460,779	16,000		
Total	4,404	27,762	26,578,740	1,141,069	16,250	721	9,535,417	293,541		
LANDED AT GLOUCESTER										
East of 66° W. longitude:										
La Have Bank	17	286	825,080	19,372	73,185	3,565	161,165	2,937	13,130	$542
Western Bank	96	1,789	7,633,540	170,835	1,010,661	47,941	1,813,385	32,956	352,752	14,562
Quereau Bank	26	624	907,195	20,284	349,560	17,045	253,765	4,422	121,800	4,954
Green Bank	2	58	730	9	5,490	260	100	1	430	16
Grand Bank	1	27			11,840	562			1,900	76
St. Peters Bank	5	119	6,990	157	40,190	1,906	475	8	10,735	446
Burgeo Bank	2	57			19,325	918			4,105	164
Off Newfoundland	8	432								
Cape Shore	12	288								
Gulf of St. Lawrence	2	52	24,065	1,143	4,675	302	9,920	397	1,810	72
Strait of Belleisle	2	56			5,580	265			3,780	161
West of 66° W. longitude:										
Browns Bank	31	402	748,555	19,405	124,535	4,263	356,490	7,482	14,200	403
Georges Bank	205	2,704	5,853,440	134,752	600,085	30,186	1,041,600	20,040	151,465	6,451
Middle Bank	243	999	193,200	4,336			28,200	485		
Jeffreys Ledge	14	41								
South Channel	50	422	122,975	2,997	7,800	371	81,730	1,621	8,940	358
Nantucket Shoals	6	49	9,970	1,143			47,235	944		
Off Chatham	27	219								
Seal Island	1	23	11,600	290	7,800	371			1,200	48
Shore, general	1,741	2,388	3,461,255	162,177	1,818	91	64,620	2,800	301	12
Total	2,491	11,035	19,798,595	536,900	2,262,544	108,046	3,858,685	74,093	686,548	28,265

Statement, by fishing grounds, of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American fishing vessels, 1925—Continued

Fishing grounds	Trips	Days absent	Cod							
			Large (10 pounds and over)				Market (under 10 and over 2½ pounds)			
			Fresh		Salted		Fresh		Salted	
LANDED AT PORTLAND										
East of 66° W. longitude:			*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
La Have Bank	3	30								
Western Bank	32	416	1,296,560	$25,441	20,600	$975	88,335	$1,951	4,720	$191
Quereau Bank	8	189	8,230	250	4,345	185	3,215	70		
Grand Bank	1	5	3,240	81			1,150	23		
St. Peters Bank	2	51	7,300	231			1,485	48		
Cape Shore	5	116								
Gulf of St. Lawrence	1	(1)								
St. Anns Bank	1	22								
The Gully	2	41	15,200	598	18,600	930	4,820	163	4,585	183
West of 66° W. longitude:										
Browns Bank	9	154	107,375	3,913	36,520	1,735	25,200	979	8,000	320
Georges Bank	18	318	234,870	4,042	6,425	321	925	42	3,525	150
Cashes Bank	57	167	169,749	5,268			82,548	1,976		
Fippenies Bank	28	56	39,850	1,949			28,990	931		
Middle Bank	1	2	2,080	73			730	18		
Platts Bank	145	247	177,069	9,190			67,950	2,554		
Jeffreys Ledge	333	525	322,390	13,647			79,484	2,583		
South Channel	6	52	53,860	1,764			8,500	177		
Nantucket Shoals	5	45	7,390	172						
Seal Island	5	79	6,320	141	39,548	1,660	2,475	43	11,145	396
Shore, general	848	1,135	1,151,254	45,836	910	43	128,011	3,814	175	7
Total	1,509	3,650	3,602,737	112,596	126,948	5,849	523,818	15,372	32,150	1,247
Grand total	8,404	42,447	49,980,072	1,790,565	2,405,742	114,616	13,917,920	383,006	718,698	29,512

[1] Included in the statistics for Gloucester.

Statement, by fishing grounds, of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American fishing vessels, 1925—Continued

Fishing grounds	Cod—Continued				Haddock			
	Scrod (1 to 2½ pounds)				Large (over 2½ pounds)			
	Fresh		Salted		Fresh		Salted	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
LANDED AT BOSTON								
East of 66° W. longitude:								
La Have Bank	3,900	$44			713,580	$25,550		
Western Bank	13,200	154			1,216,580	39,542		
Cape Shore	800	12			104,220	3,119		
West of 66° W. longitude:								
Browns Bank	2,990	67			4,205,050	134,623		
Georges Bank	5,530	135			9,927,370	336,390		
Cashes Bank					78,460	2,694		
Fippenies Bank					51,750	1,867		
Middle Bank	2,095	37			1,468,104	69,933		
German Bank					860	26		
Jeffreys Ledge	8,370	129			2,415,670	112,269		
South Channel	8,410	137			30,832,643	1,014,469		
Nantucket Shoals	3,495	36			4,537,015	147,764		
Off Chatham	790	14			1,578,625	67,470		
Seal Island					49,300	1,128		
Shore, general	35,040	678			4,208,950	141,880		
Total	84,620	1,443			61,388,177	2,098,724		
LANDED AT GLOUCESTER								
East of 66° W. longitude:								
La Have Bank	60	1	250	$8	178,360	2,060		
Western Bank	3,890	34	7,804	259	1,460,730	20,115	16,290	$406
Quereau Bank			40	1	47,225	512	7,800	195
Green Bank			110	3				
Gulf of St. Lawrence	600	15						
West of 66° W. longitude:								
Browns Bank	6,095	65			336,580	5,460		
Georges Bank	1,975	20	790	21	3,341,685	44,017		
South Channel	330	4			1,839,385	23,319		
Nantucket Shoals	260	3			306,770	4,228		
Shore, general			185	4	1,011,775	36,941		
Total	13,210	142	9,179	296	8,522,510	136,652	24,090	601
LANDED AT PORTLAND								
East of 66° W. longitude:								
Western Bank			18,044	463	3,058,585	58,451	385	10
Quereau Bank	90	1						
St. Peters Bank					310	10		
The Gully			1,100	22				
West of 66° W. longitude:								
Browns Bank	260	3			47,305	3,530		
Georges Bank					400,000	7,545		
Cashes Bank	17,300	165			163,152	6,022		
Fippenies Bank	7,225	114			82,936	4,138		
Middle Bank	175	2			1 4,770	775		
Platts Bank	18,955	273			509,455	26,500		
Jeffreys Ledge	29,102	300			1,009,804	47,470		
South Channel					395,950	9,245		
Nantucket Shoals					724,300	13,994		
Seal Island			350	10				
Shore, general	28,088	305			972,631	34,681		
Total	101,195	1,163	19,494	495	7,379,198	212,361	385	10
Grand total	199,025	2,748	28,673	791	77,289,885	2,447,737	24,475	611

Statement, by fishing grounds, of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American fishing vessels, 1925—Continued

Fishing grounds	Haddock—Continued				Hake			
	Scrod (1 to 2½ pounds)				Large (6 pounds and over)			
	Fresh		Salted		Fresh		Salted	
LANDED AT BOSTON								
East of 66° W. longitude:	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
La Have Bank	36,575	$748						
Western Bank	41,800	559			14,725	$726		
Quereau Bank					1,500	60		
Cape Shore	6,850	54						
West of 66° W. longitude:								
Browns Bank	65,825	1,333			23,490	1,106		
Georges Bank	1,857,780	51,308			29,600	1,274		
Cashes Bank	6,720	106			15,485	481		
Fippenies Bank	3,000	48			3,670	97		
Middle Bank	133,790	3,070			108,735	4,190		
Jeffreys Ledge	270,650	6,391			238,235	8,732		
South Channel	8,115,170	173,265			1,013,250	42,959		
Nantucket Shoals	905,900	17,733			33,640	990		
Off Chatham	218,860	4,619			98,315	6,841		
Seal Island	8,500	91			1,000	20		
Shore, general	1,221,655	20,361			121,268	2,776		
Total	12,893,075	279,686			1,702,913	70,252		
LANDED AT GLOUCESTER								
East of 66° W. longitude:								
La Have Bank					5,555	74	1,360	$34
Western Bank					47,635	622	4,190	89
Quereau Bank					9,600	121	395	8
St. Peters Bank					1,680	21	195	5
Burgeo Bank					1,200	15		
Strait of Belleisle					1,280	16	100	1
West of 66° W. longitude:								
Browns Bank					7,375	92	400	10
Georges Bank	416,900	4,503			26,820	338	9,240	219
South Channel	604,135	5,830			30,740	382		
Nantucket Shoals	13,800	173			2,240	33		
Shore, general					169,690	3,118		
Total	1,034,835	10,506			303,815	4,832	15,880	366
LANDED AT PORTLAND								
East of 66° W. longitude:								
Western Bank	3,500	35	770	$21				
Grand Bank					860	11		
West of 66° W. longitude:								
Browns Bank	1,360	36						
Cashes Bank	25,215	252			2,775	130		
Fippenies Bank	19,130	254			900	36		
Middle Bank	1,270	13						
Platts Bank	83,608	1,451						
Jeffreys Ledge	160,339	1,979			755	23		
South Channel	220,500	3,917			3,500	35		
Shore, general	128,298	1,243			7,860	283		
Total	643,220	9,180	770	21	16,650	518		
Grand total	14,571,130	299,372	770	21	2,023,378	75,602	15,880	366

Statement, by fishing grounds, of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American fishing vessels, 1925—Continued

Fishing grounds	Hake—Continued				Pollock			
	Small (under 6 pounds)							
	Fresh		Salted		Fresh		Salted	
LANDED AT BOSTON								
East of 66° W. longitude:	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
La Have Bank	100	$1			39,120	$1,035		
Western Bank	5,090	150			364,365	10,623		
Quereau Bank	2,900	58						
Grand Bank					1,500	30		
Cape Shore					2,805	48		
West of 66° W. longitude:								
Browns Bank	33,495	945			164,230	5,170		
Georges Bank	55,895	1,612			413,060	13,119		
Cashes Bank	55,635	1,200			9,445	296		
Fippenies Bank	12,375	293			4,910	139		
Middle Bank	192,945	5,259			76,495	1,880		
German Bank					240	7		
Jeffreys Ledge	300,025	7,614			183,596	4,223		
South Channel	2,024,053	51,715			1,163,741	42,939		
Nantucket Shoals	62,085	2,454			153,240	5,207		
Off Chatham	68,085	1,727			44,150	1,681		
Seal Island					200	4		
Shore, general	130,745	2,605			138,442	4,962		
Total	2,943,428	75,633			2,759,539	91,363		
LANDED AT GLOUCESTER								
East of 66° W. longitude:								
La Have Bank					16,515	226	775	$20
Western Bank					97,294	1,231	21,762	542
Quereau Bank					3,315	41	3,040	77
Gulf of St. Lawrence					120	3		
West of 66° W. longitude:								
Browns Bank					11,360	152	320	6
Georges Bank					129,235	1,717	6,395	164
South Channel					7,375	93		
Nantucket Shoals					6,710	83		
Shore, general					1,518,575	38,569		
Total					1,790,499	42,115	32,292	809
LANDED AT PORTLAND								
East of 66° W. longitude:								
Western Bank	1,575	32	410	$12	93,470	1,116	13,745	305
Quereau Bank	1,855	26						
West of 66° W. longitude:								
Browns Bank					660	24	135	5
Georges Bank					730	15		
Cashes Bank	78,589	1,713			23,521	478		
Fippenies Bank	28,695	773			7,780	192		
Middle Bank	965	52			90	2		
Platts Bank	222,135	6,565			58,809	1,226		
Jeffreys Ledge	291,143	8,284			141,742	2,761		
South Channel	680	9			2,000	25		
Nantucket Shoals	8,500	85			21,400	266		
Seal Island	1,550	19	100	2	260	4	520	14
Shore, general	186,382	4,485	455	8	342,061	6,842	620	20
Total	822,069	22,043	965	22	692,523	12,951	15,020	344
Grand total	3,765,497	97,676	965	22	5,242,561	146,429	47,312	1,153

Statement, by fishing grounds, of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American fishing vessels, 1925—Continued

Fishing grounds	Cusk				Halibut			
	Fresh		Salted		Fresh		Salted	
LANDED AT BOSTON								
East of 66° W. longitude:	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
La Have Bank	77,790	$1,829			165,549	$28,331		
Western Bank	19,190	379			123,934	22,600		
Quereau Bank	6,625	101			431,293	69,520		
Green Bank					17,491	2,420		
Grand Bank					108,429	20,716		
St. Peters Bank					163,552	32,448		
Burgeo Bank					110,173	13,151		
Cape Shore	10,905	184			802	441		
Gulf of St. Lawrence					104,824	13,380		
The Gully	8,500	213			190,572	46,433		
West of 66° W. longitude:								
Browns Bank	333,674	7,474			141,285	30,117		
Georges Bank	208,592	4,848			1,116,467	217,789		
Cashes Bank	117,330	2,250			1,325	201		
Fippenies Bank	26,750	472			776	294		
Middle Bank	181,449	5,096			4,068	1,352		
Jeffreys Ledge	295,312	8,211			3,440	1,102		
South Channel	498,840	13,305			130,424	30,364		
Nantucket Shoals					5,962	1,319		
Off Chatham	75,390	1,974			3,797	1,021		
Seal Island	19,400	337			284	139		
Shore, general	19,400	511			13,428	2,297		
Total	1,899,147	47,184			2,837,875	535,435		
LANDED AT GLOUCESTER								
East of 66° W. longitude:								
La Have Bank	104,005	1,523	2,420	$61				
Western Bank	73,865	1,049	38,990	738			225	$18
Quereau Bank	17,670	260	7,180	198	8,543	683	410	57
St. Peters Bank	455	6	140	3			285	33
Burgeo Bank			100	3	1,080	97		
Straits of Belleisle					88,975	9,063	400	56
West of 66° W. longitude:								
Browns Bank	139,530	1,928	890	27			230	21
Georges Bank	266,385	3,722	33,110	684	4,830	1,054	90	11
South Channel	28,145	340						
Seal Island	15,400	231						
Shore, general	1,030	39					5,940	238
Total	646,485	9,098	82,830	1,714	103,428	10,897	7,580	434
LANDED AT PORTLAND								
East of 66° W. longitude:								
La Have Bank					44,705	7,628		
Western Bank	22,685	303			107,451	19,103		
Quereau Bank	4,565	90			166,499	32,151		
Grand Bank	750	13			15,211	2,793		
St. Peters Bank	415	8			72,931	10,618		
Gulf of St. Lawrence					12,376	1,421		
St. Anns Bank					12,279	2,762		
The Gully	150	3			39,504	7,211		
West of 66° W. longitude:								
Browns Bank	22,448	448			21,747	4,028		
Georges Bank	3,080	62			24,775	4,750		
Cashes Bank	258,075	4,749			5,481	1,004		
Fippenies Bank	54,450	1,595			3,966	654		
Middle Bank	385	8			195	16		
Platts Bank	180,258	6,497			3,947	725		
Jeffreys Ledge	215,106	5,497			4,407	735	60	2
South Channel					999	81		
Nantucket Shoals					589	70		
Seal Island	57,520	719	24,000	300	67,383	11,497		
Shore, general	240,501	6,309			7,714	1,157		
Total	1,060,388	26,301	24,000	300	612,159	108,404	60	2
Grand total	3,606,020	82,583	106,830	2,014	3,553,462	654,736	7,640	436

Statement, by fishing grounds, of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American fishing vessels, 1925—Continued

Fishing grounds	Mackerel				Miscellaneous			
	Fresh		Salted		Fresh		Salted	
LANDED AT BOSTON								
East of 66° W. longitude:	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
La Have Bank	40,000	$1,600			31,149	$8,664		
Western Bank					47,000	5,595		
Quereau Bank					4,330	1,020		
Grand Bank					384	143		
Cape Shore	1,424,808	85,768	44,400	$2,784	105,460	31,196		
West of 66° W. longitude:								
Browns Bank					170,591	41,392		
Georges Bank	1,000	60			1,139,472	242,884		
Cashes Bank					900	9		
Middle Bank	1,797,420	66,528	2,000	160	35,375	1,491		
German Bank					800	16		
Jeffreys Ledge	1,757,375	58,130	79,800	5,987	80,774	2,966		
South Channel	1,610,380	78,093	25,600	2,031	979,576	69,470		
Nantucket Shoals	757,545	38,532	34,400	2,752	329,830	37,228		
Off Chatham	5,449,257	261,887	78,200	5,797	58,841	3,102		
Shore, general	5,249,638	246,235	34,800	2,628	5,028,212	165,079		
Total	18,087,423	836,833	299,200	22,139	8,012,694	610,255		
LANDED AT GLOUCESTER								
East of 66° W. longitude:								
Off Newfoundland							2,400,336	$84,265
Cape Shore	38,110	1,894	141,358	9,012				
West of 66° W. longitude:								
Georges Bank					7,815	2,309		
Middle Bank	3,338,870	99,797	825,665	63,190	16,000	240		
Jeffreys Ledge	134,400	3,350	10,000	800				
South Channel	103,140	3,041	143,000	11,086	40,000	300		
Off Chatham	287,380	7,706	402,800	28,661				
Shore, general	1,334,637	57,034	267,120	19,624	788,307	32,505		
Total	5,236,537	172,822	1,789,943	132,373	852,122	35,354	2,400,336	84,265
LANDED AT PORTLAND								
East of 66° W. longitude:								
Western Bank					4,660	73		
Quereau Bank					16,288	3,911		
Grand Bank					490	20		
St. Peters Bank					710	120		
Cape Shore					25,268	6,755		
West of 66° W. longitude:								
Browns Bank					41,776	10,268		
Georges Bank					99,595	21,898		
Cashes Bank					1,694	43		
Fippenies Bank					465	25		
Middle Bank					740	37		
Platts Bank					4,372	131		
Jeffreys Ledge	261,740	8,001	5,200	416	591,017	8,893		
South Channel					1,150	14		
Nantucket Shoals					1,185	12		
Shore, general	529,017	18,515	800	53	1,098,908	12,348		
Total	790,757	26,516	6,000	469	1,888,318	64,548		
Grand total	24,114,717	1,036,171	2,095,143	154,981	10,753,134	710,157	2,400,336	84,265

Statement, by fishing grounds, of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American fishing vessels, 1925—Continued

Fishing grounds	Total				Grand total	
	Fresh		Salted			
LANDED AT BOSTON						
East of 66° W. longitude:	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
La Have Bank	2,810,503	$142,398			2,810,503	$142,398
Western Bank	3,894,559	161,590			3,894,559	161,590
Quereau Bank	461,593	71,221			461,593	71,221
Green Bank	17,491	2,420			17,491	2,420
Grand Bank	121,213	21,422			121,213	21,422
St. Peters Bank	163,552	32,448			163,552	32,448
Burgeo Bank	110,173	13,151			110,173	13,151
[illegible]	1,850,705	128,215	44,000	$2,784	1,894,705	130,999
Gulf of St. Lawrence	104,824	13,380			104,824	13,380
The Gully	199,072	46,646			199,072	46,646
West of 66° W. longitude:						
Browns Bank	10,348,796	424,930			10,348,796	424,930
Georges Bank	29,353,082	1,416,304	16,250	721	29,569,332	1,417,025
Cashes Bank	451,705	13,349			451,705	13,349
Pippenass Bank	144,911	5,333			144,911	5,333
Middle Bank	4,301,531	175,927	2,000	160	4,303,531	176,087
German Bank	22,600	608			22,600	608
Jeffreys Ledge	6,020,362	236,746	79,800	5,987	6,100,162	242,730
South Channel	54,788,423	1,871,259	25,600	2,031	54,812,023	1,873,950
Nantucket Shoals	8,017,882	300,920	34,400	2,752	8,052,282	303,672
Off Chatham	7,959,108	365,928	78,200	5,797	8,037,308	371,723
[illegible]	123,134	3,378			123,134	3,378
Shore, general	17,260,229	635,150	34,800	2,628	17,295,029	635,818
Total	148,723,548	6,381,403	315,450	22,860	149,038,498	6,104,278
LANDED AT GLOUCESTER						
East of 66° W. longitude:						
La Have Bank	1,290,740	26,193	90,120	4,230	1,381,860	30,423
Western Bank	11,961,339	228,842	1,452,674	64,555	12,583,013	291,397
Quereau Bank	1,247,813	26,323	490,225	22,535	1,737,538	48,858
Green Bank	880	10	5,980	279	6,860	289
Grand Bank	[illegible]	[illegible]	13,740	638	13,740	638
St. Peters Bank	9,400	192	51,845	2,393	61,145	2,585
Burgeo Bank	2,280	112	23,530	1,085	25,810	1,197
Gulf of St. Lawrence	[illegible]	[illegible]	2,400,336	84,265	2,400,336	84,265
[illegible]	38,110	1,894	141,358	9,012	179,468	10,906
Gulf of St. Lawrence	34,700	1,568	6,485	374	41,190	1,932
The Gully	90,255	9,079	9,860	483	100,115	9,562
West of 66° W. longitude:						
Browns Bank	1,605,985	34,584	140,575	4,730	1,746,560	39,314
Georges Bank	11,090,685	242,472	801,175	37,736	11,891,860	280,208
Middle Bank	3,576,270	104,868	825,665	63,190	4,401,935	168,048
Jeffreys Ledge	134,400	3,850	10,000	800	144,400	4,650
South Channel	2,857,966	37,927	159,740	11,815	3,017,695	49,742
Nantucket Shoals	386,985	6,607			386,985	6,607
Off Chatham	287,380	7,706	402,800	28,661	690,180	36,367
Sea Isaacs	27,000	521	9,000	419	36,000	940
Shore, general	8,349,889	385,185	275,364	19,969	8,625,253	353,152
Total	42,180,721	1,068,441	7,311,222	357,169	49,471,943	1,390,580

Statement, by fishing grounds, of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American fishing vessels, 1925—Continued

Fishing grounds	Total				Grand total	
	Fresh		Salted			
LANDED AT PORTLAND						
East of 66° W. longitude:	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
La Have Bank	44,705	$7,628			44,705	$7,628
Western Bank	4,676,821	106,505	58,674	$1,977	4,735,495	108,482
Quereau Bank	200,742	36,499	4,345	185	205,087	36,684
Grand Bank	21,701	2,941			21,701	2,941
St. Peters Bank	83,151	11,035			83,151	11,035
Cape Shore	25,268	6,755			25,268	6,755
Gulf of St. Lawrence	12,376	1,421			12,376	1,421
St. Anns Bank	12,279	2,762			12,279	2,762
The Gully	59,674	7,975	24,285	1,135	83,959	9,110
West of 66° W. longitude:						
Browns Bank	268,131	23,229	44,655	2,060	312,786	25,289
Georges Bank	763,975	38,354	9,950	471	773,925	38,825
Cashes Bank	828,099	21,800			828,099	21,800
Fippenies Bank	274,387	10,661			274,387	10,661
Middle Bank	21,400	996			21,400	996
Platts Bank	1,326,558	55,112			1,326,558	55,112
Jeffreys Ledge	3,107,029	100,173	5,260	418	3,112,289	100,591
South Channel	687,139	15,267			687,139	15,267
Nantucket Shoals	763,364	14,599			763,364	14,599
Seal Island	135,508	12,423	75,663	2,382	211,171	14,805
Shore, general	4,820,725	135,818	2,960	131	4,823,685	135,949
Total	18,133,032	611,953	225,792	8,759	18,358,824	620,712
Grand total	209,016,801	7,726,782	7,852,464	388,788	216,869,265	8,115,570

NOTE.—The items under "Miscellaneous" include bluebacks, 385,837 pounds, value $5,464; bonito, 30 pounds, value $2; butterfish, 13,847 pounds, value $2,200; eels, 300 pounds, value $6; flounders 6,637,972 pounds, value $275,787; herring, fresh, 1,542,465 pounds, value $18,553; herring, salted, 2,400,336 pounds, value $84,265; menhaden, 40,000 pounds, value $300; rosefish, 54,610 pounds, value $926; salmon, 8 pounds, value $1; shad, 1,498 pounds, value $115; sharks, 9,232 pounds, value $233; skates, 49,540 pounds, value $1,019; smelt, 362 pounds, value $36; sturgeon, 2,342 pounds, value $580; swordfish, 1,527,180 pounds, value $385,929; tuna, 145 pounds, value $3; whiting, 14,565 pounds, value $533; wolffish, 299,816 pounds, value $7,149; lobster, 48 pounds, value $16; squid, 1,541 pounds, value $28; scallops, 48 pounds, value $18; spawn, 170,908 pounds, value $11,211; and tongues 840 pounds, value $48.

Statement, by months, of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American fishing vessels, 1925

Month	Trips	Days absent	Cod							
			Large (10 pounds and over)				Market (under 10 and over 2½ pounds)			
			Fresh		Salted		Fresh		Salted	
			Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
LANDED AT BOSTON										
January	261	1,661	1,468,394	$119,191			539,205	$31,088		
February	284	1,741	3,623,325	117,354			462,914	15,919		
March	355	2,238	4,060,210	138,990			571,061	19,447		
April	268	2,601	2,095,655	81,037			717,989	19,425		
May	274	2,077	1,884,939	60,293	16,250	$721	984,437	22,740		
June	394	2,813	2,199,447	77,430			991,220	24,180		
July	502	3,393	1,956,836	75,781			1,027,855	26,462		
August	560	3,277	2,303,985	83,105			1,073,958	25,768		
September	513	2,374	2,120,785	87,481			921,455	23,625		
October	431	2,178	1,791,275	111,072			844,818	32,860		
November	321	1,729	1,844,289	97,064			844,540	24,860		
December	241	1,680	1,229,600	92,181			555,965	27,167		
Total	4,404	27,762	26,578,740	1,141,069	16,250	721	9,535,417	293,541		
LANDED AT GLOUCESTER										
January	117	263	145,935	14,439			12,240	886		
February	175	445	1,366,475	35,168	24,830	1,180	53,220	1,179	2,060	$77
March	280	800	3,036,115	85,720	6,010	303	122,235	2,638	265	11
April	307	823	1,344,365	49,428	74,745	3,552	155,655	3,037	16,410	655
May	305	1,288	2,408,035	64,696	240,099	11,852	518,697	9,872	58,651	2,399
June	217	1,798	4,019,905	92,918	501,865	24,517	973,285	16,867	296,842	12,526
July	156	1,350	3,311,970	77,110	400,315	19,880	886,905	17,641	103,710	4,265
August	239	1,608	2,069,445	48,795	651,930	30,499	512,913	9,307	147,005	5,973
September	313	1,371	1,628,100	44,177	249,675	10,441	450,040	8,749	44,285	1,647
October	149	630	304,600	12,968	113,075	5,822	158,485	3,303	17,320	712
November	167	326	130,040	7,564			10,140	271		
December	66	333	33,610	3,917			4,870	343		
Total	2,491	11,035	19,798,595	536,900	2,262,544	108,046	3,858,685	74,093	686,548	28,265
LANDED AT PORTLAND										
January	104	118	67,671	6,302			29,968	1,625		
February	82	161	301,690	7,783	820	37	44,160	1,835		
March	144	237	534,129	12,617	1,985	99	60,711	1,779	950	38
April	157	379	483,379	13,718	4,345	185	145,943	3,246	1,385	55
May	124	405	837,604	19,107	19,635	979	37,995	764	6,765	280
June	132	336	374,442	11,369	10,175	229	20,554	452	2,500	50
July	160	564	348,692	13,400	38,350	1,867	12,004	304	7,085	283
August	197	530	259,378	10,543	31,888	1,515	20,270	487	10,945	438
September	129	332	189,939	7,042	19,720	937	25,124	636	2,000	80
October	109	232	83,386	4,031			41,708	1,217		
November	95	200	73,283	3,409			43,031	1,191		
December	76	156	49,144	3,275	30	1	42,350	1,836	520	23
Total	1,509	3,650	3,602,737	112,596	126,948	5,849	523,818	15,372	32,150	1,247
Grand total	8,404	42,447	49,980,072	1,790,565	2,405,742	114,616	13,917,920	383,006	718,698	29,512
Grounds east of 66° W. long	491		13,593,770	370,929	1,564,051	74,854	3,443,090	74,694	519,747	21,367
Grounds west of 66° W. long	7,913		36,386,302	1,419,636	841,691	39,762	10,474,830	308,312	198,951	8,145
Landed at Boston in 1924	3,735		24,893,292	1,070,442	17,000	613	10,959,426	324,467		
Landed at Gloucester in 1924	2,157		14,229,650	385,909	1,862,222	92,156	4,161,361	76,924	732,906	28,573
Landed at Portland in 1924	1,583		3,522,984	129,523	121,360	6,127	606,387	17,266	23,725	935

Statement, by months, of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American fishing vessels, 1925—Continued

Month	Cod—Continued				Haddock			
	Scrod (1 to 2½ pounds)				Large (over 2½ pounds)			
	Fresh		Salted		Fresh		Salted	
LANDED AT BOSTON	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
January	10,120	$255			5,025,545	$278,221		
February	3,665	121			7,051,580	238,377		
March	2,520	52			7,913,245	290,460		
April	485	6			5,265,478	161,885		
May	2,535	22			3,773,265	108,952		
June	250	3			3,945,207	86,617		
July	2,845	43			3,727,160	83,692		
August	10,055	110			4,046,813	80,318		
September	4,985	47			5,044,050	102,958		
October	5,710	95			5,454,525	220,294		
November	29,530	386			5,809,079	185,035		
December	11,920	303			4,332,230	261,915		
Total	84,620	1,443			61,388,177	2,098,724		
LANDED AT GLOUCESTER								
January					24,695	1,376		
February					570,065	9,812		
March			90	$2	1,095,595	18,388		
April	2,335	27	160	4	1,205,745	25,695		
May	3,470	35	400	9	820,455	21,046		
June	125	1	5,400	189	1,175,870	18,347		
July	5,285	57	474	15	1,035,890	13,243	7,015	$175
August	510	7	2,180	63	1,025,590	10,352	9,075	227
September	785	8			1,187,690	12,873	8,000	199
October	700	7	475	14	306,865	3,462		
November					71,940	1,899		
December					2,110	159		
Total	13,210	142	9,179	296	8,522,510	136,652	24,090	601
LANDED AT PORTLAND								
January	11,348	218			345,575	23,120		
February	8,135	141	340	7	784,045	26,359		
March	13,955	174			782,200	23,903		
April	18,344	147	7,731	187	1,318,103	28,040		
May	7,860	39	8,730	238	1,557,965	30,168		
June	2,420	16			1,039,858	19,862		
July	1,915	12	1,100	22	123,167	2,835		
August	1,730	9	350	10	141,594	4,183		
September	5,370	33			174,158	6,090		
October	12,015	100			388,612	16,282		
November	8,100	81			411,607	13,454		
December	10,003	193	1,243	31	312,314	18,065	385	10
Total	101,195	1,163	19,494	495	7,379,198	212,361	385	10
Grand total	199,025	2,748	28,673	791	77,289,885	2,447,737	24,475	611
Grounds east of 66° W. long	22,540	261	27,348	756	6,779,590	149,359	24,475	611
Grounds west of 66° W. long	176,485	2,487	1,325	35	70,510,295	2,298,378		
Landed at Boston in 1924	176,390	3,639			57,118,561	1,847,134		
Landed at Gloucester in 1924	17,515	146	30,973	943	4,673,621	84,685	323	8
Landed at Portland in 1924	88,882	529	4,680	114	6,179,070	177,330	3,095	62

Statement, by months, of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American fishing vessels, 1925—Continued

Month	Haddock—Continued				Hake			
	Scrod (1 to 1½ pounds)				Large (6 pounds and over)			
	Fresh		Salted		Fresh		Salted	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
LANDED AT BOSTON								
January	1,345,500	$41,628			171,755	$13,227		
February	1,426,380	38,024			147,990	9,010		
March	2,035,065	53,997			111,385	9,159		
April	1,209,560	22,375			166,570	9,219		
May	872,680	12,918			90,570	2,857		
June	832,940	9,230			60,095	1,372		
July	674,075	6,242			60,865	1,458		
August	622,900	5,344			23,055	598		
September	714,520	7,656			166,685	2,704		
October	1,202,275	25,788			218,420	6,332		
November	980,180	16,557			365,638	7,402		
December	977,000	39,927			119,885	6,914		
Total	12,893,075	279,686			1,702,913	70,252		
LANDED AT GLOUCESTER								
February	31,725	399						
March	160,320	2,004						
April	90,830	1,136			1,200	15		
May	57,225	715			19,710	275	435	$10
June	155,050	1,938			21,140	269	3,965	84
July	199,235	1,838			41,445	523	4,045	104
August	100,300	753			24,655	309	2,990	59
September	182,890	1,396			109,095	1,518	220	5
October	57,260	327			86,420	1,921	4,225	104
November					150	2		
Total	1,034,835	10,506			303,815	4,832	15,880	366
LANDED AT PORTLAND								
January	84,983	1,658						
February	55,227	1,022						
March	58,465	691			730	42		
April	274,645	4,408			7,745	345		
May	17,665	91	770	$21				
June	17,487	89			4,433	47		
July	15,500	107			2,320	47		
August	21,115	105			895	18		
September	21,180	125			257	5		
October	34,410	318						
November	26,167	273						
December	16,376	293			270	14		
Total	643,220	9,180	770	21	16,650	518		
Grand total	14,571,130	299,372	770	21	2,023,378	75,602	15,880	366
Grounds east of 66° W. longitude	88,725	1,396	770	21	84,035	1,666	6,240	137
Grounds west of 66° W. longitude	14,482,405	297,976			1,939,343	73,936	9,640	229
Landed at Boston in 1924	11,023,748	190,527			588,667	19,103		
Landed at Gloucester in 1924	468,165	5,009			251,099	4,794	20,134	350
Landed at Portland in 1924	433,827	3,823	1,365	27	19,775	777		

Statement, by months, of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American fishing vessels, 1925—Continued

Month	Hake—Continued				Pollock			
	Small (under 6 pounds)							
	Fresh		Salted		Fresh		Salted	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
LANDED AT BOSTON								
January	83,595	$3,813			153,732	$10,508		
February	69,485	3,012			181,930	7,504		
March	54,780	2,836			72,580	3,822		
April	54,815	1,789			105,031	4,687		
May	88,445	1,920			98,370	3,494		
June	171,760	4,761			162,665	5,554		
July	295,175	6,589			214,610	6,594		
August	234,305	5,933			294,000	7,807		
September	493,693	8,323			316,860	7,064		
October	699,305	18,742			340,745	8,124		
November	576,035	10,968			469,976	9,918		
December	122,035	6,947			349,040	16,287		
Total	2,943,428	75,633			2,759,539	91,363		
LANDED AT GLOUCESTER								
January					3,375	288		
February					6,325	175		
March					10,840	136		
April					21,520	269	695	$18
May					20,215	268	650	16
June					21,989	277	3,960	99
July					34,710	457	5,205	136
August					38,905	487	13,120	329
September					308,485	5,957	7,047	171
October					475,190	13,084	1,615	40
November					694,765	13,179		
December					154,180	7,538		
Total					1,790,499	42,115	32,292	809
LANDED AT PORTLAND								
January	64,090	3,729			64,379	733		
February	30,481	1,286			7,895	237	40	1
March	26,979	1,013			45,488	700		
April	27,028	835			52,363	790	8,865	209
May	91,697	1,619	310	$7	48,508	671	4,840	95
June	29,606	514			61,709	1,396	170	3
July	29,521	550	245	3	148,006	3,193		
August	23,733	432			83,852	1,829	350	11
September	67,235	1,458			56,824	1,104	135	5
October	195,674	4,785			69,456	1,185	620	20
November	179,080	3,457			34,180	565		
December	56,945	2,365	410	12	19,863	548		
Total	822,069	22,043	965	22	692,523	12,951	15,020	344
Grand total	3,765,497	97,676	965	22	5,242,561	146,429	47,312	1,153
Grounds east of 66° W. longitude	11,520	267	410	12	618,504	14,353	39,322	944
Grounds west of 66° W. longitude	3,753,977	97,409	555	10	4,624,057	132,076	7,990	209
Landed at Boston in 1924	5,110,027	129,356	1,150	32	2,144,519	84,287		
Landed at Gloucester in 1924					2,289,593	60,640	11,390	214
Landed at Portland in 1924	1,293,169	31,677	590	12	632,826	14,179	6,950	118

Statement, by months, of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American fishing vessels, 1925—Continued

Month	Cusk				Halibut			
	Fresh		Salted		Fresh		Salted	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
LANDED AT BOSTON								
January	191,979	$7,210			18,179	$7,343		
February	218,670	6,648			156,151	35,234		
March	234,387	6,454			160,927	37,688		
April	256,130	5,164			484,137	79,446		
May	174,945	2,845			622,772	103,275		
June	75,645	1,709			387,174	65,423		
July	52,425	1,121			351,588	66,320		
August	76,615	1,610			255,386	49,607		
September	74,899	1,817			234,093	49,273		
October	177,772	3,744			150,514	34,270		
November	248,270	4,584			9,701	3,908		
December	117,410	4,278			7,253	3,648		
Total	1,899,147	47,184			2,837,875	535,435		
LANDED AT GLOUCESTER								
February							75	$8
March	4,270	42						
April	101,395	1,488	100	$3	1,080	97		
May	117,530	1,617	1,060	27	128	10		
June	82,070	1,188	6,185	165	102,160	10,785	810	113
July	123,155	1,788	20,395	462			210	25
August	72,960	1,014	4,475	121			310	28
September	79,030	1,011	48,260	875			235	22
October	60,495	884	2,355	61	60	5		
November	5,580	66						
December							5,940	238
Total	646,485	9,098	82,830	1,714	103,428	10,897	7,580	434
LANDED AT PORTLAND								
January	120,835	6,043			940	214		
February	117,653	3,435			1,444	305		
March	289,143	5,918			21,468	3,518	60	2
April	178,245	3,554			34,357	6,913		
May	94,421	1,447			90,215	15,944		
June	17,399	346	24,000	300	118,159	19,335		
July	29,950	474			110,794	20,989		
August	20,440	304			122,665	22,626		
September	28,821	524			101,247	16,044		
October	58,458	1,227			8,756	2,108		
November	61,845	1,130			1,468	256		
December	43,178	1,899			646	152		
Total	1,060,388	26,301	24,000	300	612,159	108,404	60	2
Grand total	3,606,020	82,583	106,830	2,014	3,553,462	654,736	7,640	436
Grounds east of 66° W. longitude	347,570	5,961	48,830	1,003	1,986,173	342,970	1,320	164
Grounds west of 66° W. longitude	3,258,450	76,622	58,000	1,011	1,567,289	311,766	6,320	272
Landed at Boston in 1924	1,860,576	38,443			3,934,627	711,946		
Landed at Gloucester in 1924	691,395	11,009	55,515	1,309	10,605	954	530	58
Landed at Portland in 1924	792,035	17,199	6,070	154	476,384	76,651		

Statement, by months, of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American fishing vessels, 1925—Continued

Month	Mackerel				Miscellaneous [1]			
	Fresh		Salted		Fresh		Salted	
LANDED AT BOSTON	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
January					476,646	$28,198		
February					686,323	27,278		
March					780,928	26,282		
April					636,091	18,004		
May	91,680	$10,717			601,810	12,540		
June	2,109,136	126,073	44,400	$2,784	712,457	43,676		
July	3,157,685	178,583	42,600	3,367	1,274,956	190,038		
August	5,253,069	215,818	105,800	8,241	997,121	132,456		
September	5,324,023	170,311	106,400	7,747	585,135	45,319		
October	2,113,610	128,295			414,158	25,458		
November	38,220	7,036			357,648	21,062		
December					489,421	39,944		
Total	18,087,423	836,833	299,200	22,139	8,012,694	610,255		
LANDED AT GLOUCESTER								
January					166,780	11,110	278,000	$10,650
February					168,417	9,299		
March					81,390	3,601		
April					90,700	2,268		
May	74,284	5,354			44,000	660		
June	152,568	8,792	141,358	9,012	141,415	4,101		
July	114,820	6,367	137,400	10,855	40,000	300		
August	2,074,760	61,056	639,265	47,368	30,000	450		
September	2,589,700	72,866	727,400	55,038				
October	179,770	8,662	144,520	10,100	10,000	100		
November	50,635	9,725			29,800	827	757,400	28,552
December					49,620	2,638	1,364,936	45,063
Total	5,236,537	172,822	1,789,943	132,373	852,122	35,354	2,400,336	84,265
LANDED AT PORTLAND								
January					4,336	144		
February					25,310	616		
March					11,351	374		
April					7,596	146		
May	120	19			6,817	110		
June	41,203	2,487			142,900	2,114		
July	5,601	507			204,145	22,192		
August	392,916	13,200	5,640	445	781,399	28,008		
September	348,308	10,217	360	24	318,537	7,721		
October	2,609	86			319,614	2,560		
November					64,684	518		
December					1,629	45		
Total	790,757	26,516	6,000	469	1,888,318	64,548		
Grand total	24,114,717	1,036,171	2,095,143	154,981	10,753,134	710,157	2,400,336	84,265
Grounds east of 66° W. longitude	1,502,918	89,262	185,758	11,796	235,739	57,497	2,400,336	84,265
Grounds west of 66° W. longitude	22,611,799	946,909	1,909,385	143,185	10,517,395	652,660		
Landed at Boston in 1924	6,181,439	337,933	137,070	9,983	6,639,764	629,185	180,000	4,500
Landed at Gloucester in 1924	1,835,861	91,093	1,105,124	80,394	634,458	12,437	2,763,480	103,871
Landed at Portland in 1924	457,022	21,297	40,993	1,084	1,424,829	51,002		

[1] Includes herring from Newfoundland, 2,400,336 pounds, salted, valued at $84,265.

Statement, by months, of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American fishing vessels, 1925—Continued

Month	Total				Grand total	
	Fresh		Salted			
LANDED AT BOSTON	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
January	9,484,650	$540,682			9,484,650	$540,682
February	14,028,413	498,481			14,028,413	498,481
March	15,997,088	589,187			15,997,088	589,187
April	10,991,941	403,037			10,991,941	403,037
May	9,286,448	342,573	16,250	$721	9,302,698	343,294
June	11,647,996	446,028	44,400	2,784	11,692,396	448,812
July	12,796,075	643,013	42,600	3,367	12,838,675	646,380
August	15,191,262	608,474	105,800	8,241	15,297,062	616,715
September	16,001,183	506,578	106,400	7,747	16,107,583	514,325
October	13,413,127	615,074			13,413,127	615,074
November	11,573,106	388,780			11,573,106	388,780
December	8,311,759	499,511			8,311,759	499,511
Total	148,723,048	6,081,418	315,450	22,860	149,038,498	6,104,278
LANDED AT GLOUCESTER						
January	353,025	28,099	278,000	10,650	631,025	38,749
February	2,196,227	56,032	26,965	1,265	2,223,192	57,297
March	4,510,765	112,529	6,365	316	4,517,130	112,845
April	3,014,825	83,460	92,110	4,232	3,106,935	87,692
May	4,083,749	104,548	301,295	14,313	4,385,044	118,861
June	6,845,577	155,483	960,385	46,705	7,805,962	202,188
July	5,793,415	119,324	678,769	35,917	6,472,184	155,241
August	5,950,038	132,530	1,470,350	84,667	7,420,388	217,197
September	6,535,815	148,555	1,085,122	68,398	7,620,937	216,953
October	1,639,845	44,723	283,585	16,853	1,923,430	61,576
November	993,050	33,533	757,400	28,552	1,750,450	62,085
December	244,390	14,595	1,370,876	45,301	1,615,266	59,896
Total	42,160,721	1,033,411	7,311,222	357,169	49,471,943	1,390,580
LANDED AT PORTLAND						
January	794,125	43,786			794,125	43,786
February	1,376,040	43,019	1,200	45	1,377,240	43,064
March	1,844,619	50,729	2,995	139	1,847,614	50,868
April	2,547,748	62,142	22,326	636	2,570,074	62,778
May	2,790,867	69,979	41,050	1,620	2,831,917	71,599
June	1,870,170	58,027	36,845	582	1,907,015	58,609
July	1,031,615	64,610	46,780	2,175	1,078,395	66,785
August	1,869,987	81,744	49,173	2,419	1,919,160	84,163
September	1,337,000	50,999	22,215	1,046	1,359,215	52,045
October	1,214,698	33,899	620	20	1,215,318	33,919
November	903,445	24,334			903,445	24,334
December	552,718	28,685	2,588	77	555,306	28,762
Total	18,133,032	611,953	225,792	8,759	18,358,824	620,712
Grand total	209,016,801	7,726,782	7,852,464	388,788	216,869,265	8,115,570
Grounds east of 66° W. longitude	28,714,174	1,108,615	4,818,607	195,930	33,532,781	1,304,545
Grounds west of 66° W. longitude	180,302,627	6,618,167	3,033,857	192,858	183,336,484	6,811,025
Landed at Boston in 1924	130,631,036	5,386,462	335,220	15,128	130,966,256	5,401,590
Landed at Gloucester in 1924	29,263,323	733,600	6,582,597	307,876	35,845,920	1,041,476
Landed at Portland in 1924	15,927,190	541,253	208,828	8,633	16,136,018	549,886

The fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by fishing vessels each year are taken chiefly from fishing grounds off the coast of the United States. In the calendar year 1925, 84.37 per cent of the quantity and 83.69 per cent of the value were from these grounds; 1.44 per cent of the quantity and 2.24 per cent of the value, consisting principally of cod, halibut, and herring, were from fishing banks off the coast of Newfoundland; and

14.19 per cent of the quantity and 14.07 per cent of the value were from fishing grounds off the Canadian Provinces. Compared with the previous year, there was some increase in the percentage of products from grounds off the coast of the United States and a decrease from grounds off Newfoundland and the Canadian Provinces. Newfoundland herring constituted 1.11 per cent of the quantity and 1.04 per cent of the value of the fishery products landed at these ports by fishing vessels during the year. The herring were taken from the treaty coast of Newfoundland and the cod, haddock, hake, halibut, and other species from that region were obtained from fishing banks on the high seas. All fish caught by American fishing vessels off the coast of the Canadian Provinces were from offshore fishing grounds. The catch from each of these regions is shown in detail in the following table:

Quantity and value of fish landed by American fishing vessels at Boston and Gloucester, Mass., and Portland, Me., in 1925, from fishing grounds off the coasts specified

Species	United States		Newfoundland		Canadian Provinces		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Cod:								
Fresh	46,972,772	$1,728,302	32,370	$1,091	17,091,875	$446,926	64,097,017	$2,176,319
Salted	981,924	45,457	103,485	4,777	2,067,704	94,685	3,153,113	144,919
Haddock:								
Fresh	84,934,900	2,595,135	310	10	6,925,80	151,964	91,861,015	2,747,109
Salted					25,245	632	25,245	632
Hake:								
Fresh	5,690,770	171,306	5,020	63	93,085	1,909	5,788,875	173,278
Salted	10,095	237	295	6	6,455	145	16,845	388
Pollock:								
Fresh	4,623,597	132,068	1,500	30	617,464	14,331	5,242,561	146,429
Salted	7,470	195			39,842	958	47,312	1,153
Cusk:								
Fresh	3,166,130	75,335	1,620	27	438,270	7,221	3,606,020	82,583
Salted	34,000	711	240	6	72,590	1,297	106,830	2,014
Halibut:								
Fresh	1,499,622	300,130	577,842	91,306	1,475,998	263,300	3,553,462	654,736
Salted	6,320	272	685	89	635	75	7,640	436
Mackerel:								
Fresh	22,611,799	946,909			1,502,918	89,262	24,114,717	1,036,171
Salted	1,909,385	143,185			185,758	11,796	2,095,143	154,981
Herring:								
Fresh	1,542,465	18,553					1,542,465	18,553
Salted			2,400,336	84,265			2,400,336	84,265
Swordfish: Fresh	1,324,026	329,597	744	235	202,410	56,097	1,527,180	385,929
Miscellaneous: Fresh	7,650,904	304,510	840	48	31,745	1,117	7,683,489	305,675
Total	182,966,179	6,791,902	3,125,287	181,953	30,777,799	1,141,715	216,869,265	8,115,570

SPECIES

Cod.—In 1925 there were 3 vessels in the salt-bank fishery and 100 in the market fishery, or 2 vessels less in each of these fisheries than in 1924. These vessels landed their fares of cod, haddock, and other ground fish at these ports during the year, and large quantities also were landed by vessels fishing on the shore grounds. The catch of cod landed at these ports during the year was 67,250,130 pounds, valued at $2,321,238, of which 64,097,017 pounds, valued at $2,176,319, were landed fresh, and 3,153,113 pounds valued at $144,919 were landed salted. Cod ranked second in both quantity and value among the various species.

Haddock.—Haddock ranked first in both quantity and value, the catch exceeding that of cod by 24,636,130 pounds and $426,503 in value. The quantity of haddock landed at these ports by fishing vessels during the year was 91,886,260 pounds valued at $2,747,741, all fresh except 25,245 pounds valued at $632, salted. These fish were taken chiefly from Browns Bank, Georges Bank, South Channel, Nantucket Shoals, and shore grounds; and about 48 per cent of the quantity and 45 per cent of the value were taken in the otter-trawl fishery. The greater part of the catch, or 74,281,252 pounds, valued at $2,378,410, was landed at Boston.

Hake.—The catch of hake amounted to 5,805,720 pounds valued at $173,666, all landed fresh except 16,845 pounds valued at $388, salted. Of this catch 4,646,341 pounds valued at $145,885 were landed at Boston, 319,695 pounds valued at $5,198 at Gloucester, and 839,694 pounds valued at $22,583 at Portland. More than half of the catch, or 3,072,223 pounds, valued at $95,100, was taken in South Channel; and about 80 per cent of the quantity at 84 per cent of the value were landed at Boston.

Pollock.—The catch of pollock amounted to 5,289,873 pounds valued at $147,582, all landed fresh except 47,312 pounds salted, valued at $1,153. The greater part of the catch was obtained from Georges Bank, South Channel, and the shore grounds, and most of it was landed at Boston and Gloucester.

Cusk.—The catch of cusk amounted to 3,712,850 pounds valued at $84,597, all landed fresh except 106,830 pounds salted, valued at $2,014. More than half of the catch was landed at Boston. Compared with the previous year there was an increase in the catch of cusk of 307,259 pounds and $16,483 in the value.

Halibut.—The catch of halibut amounted to 3,561,102 pounds valued at $655,172, all landed fresh except 7,640 pounds salted, valued at $436. There was a decrease of 19.47 per cent in the quantity and 17.03 per cent in the value of the halibut landed, as compared with the previous year. The quantity landed at Boston was 2,837,875 pounds valued at $535,435, at Gloucester 111,008 pounds valued at $11,331, and at Portland 612,219 pounds valued at $108,406.

Mackerel.—The catch of mackerel was larger in 1925 than in any year since 1885. The total catch of fresh mackerel taken by the American fishing fleet in 1925 was 203,961 barrels, or 30,594,150 pounds, compared with 102,067 barrels, or 15,310,050 pounds, in 1924, an increase of 101,894 barrels, or 15,284,100 pounds. The total catch of salted mackerel landed by the fishing fleet was 12,442 barrels, or 2,488,400 pounds, compared with 10,841 barrels, or 2,168,200 pounds, in 1924, an increase of 1,601 barrels, or 320,200 pounds. In 1925 about 20,000 barrels of salted mackerel were prepared from mackerel landed fresh, as compared with about 8,000 barrels in 1924. The quantity of mackerel landed at Boston, Gloucester, and Portland by fishing vessels during the year was 26,209,860 pounds, valued at $1,191,152, of which 24,114,717 pounds, valued at $1,036,171, were fresh and 2,095,143 pounds, valued at $154,981, were salted. There was an increase in the total catch of mackerel landed by fishing vessels at these ports of 16,452,351 pounds and of $649,368 in value as compared with 1924.

In 1925 the catch of mackerel up to July 1 was 46,934 barrels fresh and 1,075 barrels salted, compared with 38,916 barrels fresh and 860 barrels salted up to July 3 in 1924. The southern mackerel fleet consisted of about 33 purse-seine vessels and about the usual number of gill-net vessels. The catch taken by seiners was the largest for a number of years. The netters also had a successful season. The first arrivals were at Cape May on April 13 and consisted of five fares amounting to about 87,000 pounds. The fish were shipped to New York and Boston, where they were sold at 23 to 25 cents per pound. The first arrival at Boston direct from the southern fleet was on May 6 and consisted of about 3,000 pounds of large and medium mackerel, which were sold at 19 cents per pound. In June small mackerel weighing about 1 pound each were caught in the vicinity of Block Island and along the shore to Boston Bay. The traps at Provincetown also caught mackerel of about this size. Good catches of mackerel also were taken along the coast of New Jersey in June. These were small fish that weighed from three-quarters of a pound to 1 pound each. The Cape Shore catch of fresh mackerel was the largest since 1921, and the salted catch was the largest since 1922. The mackerel landed included large and medium fish, such as usually are landed from this fishing ground. The first trip of mackerel from Cape Shore was landed at Boston on May 28 and consisted of 24,000 pounds of large and medium fish, which were sold at 13 cents per pound. Fresh mackerel from Cape Shore sold during the season at from 4½ to 13 cents per pound, and salted mackerel brought $12 to $13 per barrel. The Cape Shore catch of mackerel for the past five years, shown in pounds, was as follows:

Year	Trips	Fresh	Salted
1925	34	1,545,000	215,000
1924	24	996,000	170,800
1923	31	1,240,680	42,200
1922	38	1,353,900	468,800
1921	29	2,160,100	628,400

Swordfish.—The catch of swordfish amounted to 1,527,180 pounds, valued at $385,929. There were 41 vessels engaged in this fishery, or 4 less than in the previous year. There was a decrease in the catch, as compared with the previous year, amounting to 24.52 per cent in quantity and 14.21 per cent in value.

Flounders.—The catch of flounders taken in the vessel fisheries amounted to 6,637,972 pounds, valued at $275,787, an increase of 2,302,745 pounds, or 53.12 per cent, in quantity, and of $84,272, or 44 per cent, in value. The catch taken by boats under 5 tons net tonnage is not included in these statistics.

Herring.—The catch of herring amounted to 3,942,801 pounds, valued at $102,818. Of this quantity 1,542,465 pounds, valued at $18,553, were taken off the coast of the United States and landed fresh. The rest, consisting of 2,400,336 pounds salted, valued at $84,265, were Newfoundland herring.

OTTER-TRAWL FISHERY

In 1925 there were 607 trips landed at Boston, Gloucester, and Portland by 29 otter-trawl vessels, amounting to 54,605,918 pounds of fish, valued at $1,682,768, or 25.18 per cent of the quantity and 20.74 per cent of the value of the total catch landed by fishing vessels at these ports during the year. In making these trips (including the date of departure and date of arrival) the vessels were absent from port 5,059 days. The catch included cod, 7,309,930 pounds, valued at $260,133; haddock, 44,034,281 pounds, valued at $1,238,577; hake, 711,212 pounds, valued at $25,898; pollock, 1,179,347 pounds, valued at $43,832; cusk, 12,010 pounds, valued at $828; halibut, 84,619 pounds, valued at $19,626; and other species, 1,274,519 pounds, valued at $93,874. Otter trawls catch chiefly haddock, and in 1925 their catch amounted to 47.92 per cent of the quantity and 45.08 per cent of the value of the entire catch of this species landed by fishing vessels at these ports. The otter-trawl catch was taken chiefly from Western Bank, Georges Bank, South Channel, and Nantucket Shoals.

Compared with 1924, there was a decrease of 3 vessels in the otter-trawl fishery but an increase of 64 trips. There was an increase, also, of 7,902,883 pounds, or 16.92 per cent, in the quantity, and $355,037, or 26.74 per cent, in the value of fish landed.

The following tables give the catch landed by otter trawlers at these ports in 1925, by fishing grounds and by months, and also the catch of cod, haddock, and hake landed by them in various years.

Fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by otter trawlers in 1925

[Salt fish have been reduced to the basis of weights of fresh fish]

	Trips	Days absent	Cod		Haddock		Hake		Pollock	
BY FISHING GROUNDS										
East of 66° W. longitude:			*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Western Bank	72	859	3,426,939	$99,959	4,743,538	$103,528	7,927	$103	504,436	$12,253
West of 66° W. longitude:										
Georges Bank	104	875	1,699,110	67,418	7,618,270	212,458	16,605	651	36,365	1,907
South Channel	351	2,687	1,926,696	82,214	25,221,168	736,132	573,475	21,111	482,896	24,566
Nantucket Shoals	75	596	236,035	9,597	6,283,905	178,351	104,145	3,527	149,350	4,805
Off Chatham	3	25	7,250	449	112,800	6,780	6,935	471	5,900	281
Shore, general	2	17	13,900	496	55,500	1,328	2,125	35	400	20
Total	607	5,059	7,309,930	260,133	44,034,281	1,238,577	711,212	25,898	1,179,347	43,832
BY MONTHS										
January	52	460	466,532	36,525	3,061,360	137,694	34,930	2,777	90,102	6,977
February	60	476	771,201	28,591	4,839,640	155,712	32,685	2,479	124,411	5,480
March	74	592	1,218,402	35,507	5,879,423	178,310	25,095	2,305	84,831	3,357
April	56	494	822,279	23,738	4,936,305	114,947	38,120	1,811	114,402	2,975
May	45	430	996,852	21,806	4,033,575	86,509	86,330	1,895	91,076	1,998
June	49	436	393,760	9,202	3,476,270	57,121	96,420	2,151	23,950	568
July	41	334	374,305	9,072	2,645,390	37,875	63,070	1,421	7,880	143
August	32	255	445,497	10,772	2,018,235	26,727	55,860	1,460	13,205	381
September	40	305	368,035	11,790	2,678,940	41,010	80,785	1,486	58,345	1,450
October	43	354	438,155	22,741	3,050,595	89,423	65,575	1,506	78,725	2,265
November	49	437	795,435	32,275	3,423,450	92,224	46,750	851	214,155	4,580
December	66	486	219,477	18,114	3,991,098	221,025	85,592	5,756	278,265	13,658
Total	607	5,059	7,309,930	260,133	44,034,281	1,238,577	711,212	25,898	1,179,347	43,832

Fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by otter trawlers in 1925—Continued

	Cusk		Halibut		Miscellaneous		Total	
BY FISHING GROUNDS								
East of 66° W. longitude:	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Western Bank			19,890	$2,889	31,245	$1,092	8,733,975	$219,824
West of 66° W. longitude:								
Georges Bank	5,805	$325	16,238	4,269	159,370	16,306	9,551,763	303,334
South Channel	6,205	503	44,897	11,639	902,688	64,762	29,158,025	940,927
Nantucket Shoals			3,504	803	168,111	10,893	6,944,150	207,976
Off Chatham			19	7	9,890	685	142,794	8,673
Shore, general			71	19	3,215	136	75,211	2,034
Total	12,010	828	84,619	19,626	1,274,519	93,874	54,605,918	1,682,768
BY MONTHS								
January	650	74	4,143	1,588	120,383	12,288	3,778,100	197,923
February	240	10	9,815	3,161	143,275	9,841	5,921,267	205,274
March	2,665	165	14,828	3,129	84,440	5,892	7,309,684	228,665
April			17,280	2,949	96,940	3,957	6,025,326	150,377
May			8,206	1,227	97,595	2,652	5,313,634	116,087
June	6,705	273	5,664	874	98,460	3,612	4,101,229	73,801
July			3,540	651	107,320	4,940	3,201,505	54,102
August			5,603	1,119	86,288	4,260	2,624,688	44,719
September			4,791	996	36,301	2,264	3,227,197	58,996
October			6,013	1,716	117,270	10,661	3,756,333	128,312
November			1,687	714	88,301	7,766	4,569,778	138,410
December	1,750	306	3,049	1,502	197,946	25,741	4,777,177	286,102
Total	12,010	828	84,619	19,626	1,274,519	93,874	54,605,918	1,682,768

Cod, haddock, and hake landed at Boston and Gloucester, Mass., and Portland, Me., by otter trawlers in various years

Year	Trips	Cod	Haddock	Hake	Year	Trips	Cod	Haddock	Hake
		Pounds	*Pounds*	*Pounds*			*Pounds*	*Pounds*	*Pounds*
1908	44	209,800	1,542,000	46,600	1920	646	6,311,389	51,962,457	
1909	47	159,800	1,719,000	74,400	1921	346	2,482,833	26,734,893	241,650
1910	59	125,850	2,775,000	46,600	1922	578	11,161,947	35,878,524	576,370
1911	178	564,500	7,367,100	151,700	1923	665	14,961,590	35,527,297	471,660
1912	295	1,952,950	12,966,700	105,500	1924	543	8,231,430	35,197,940	616,853
1913	326	1,667,806	12,488,992	209,485	1925	607	7,309,930	44,034,281	711,212
1914	387	1,149,595	15,383,550	259,913					

DAYS' ABSENCE

In order to provide additional information on the fishing effort, statistics of the number of days' absence of vessels on fishing trips from Boston, and Gloucester, Mass., and Portland, Me., have been collected for 1925. The days absent on each trip were reckoned to include the date of departure and date of arrival. The number of days occupied in fishing by all vessels was 42,447, or an average of 5.05 days per trip. The number of days occupied in fishing by otter trawlers was 5,059, or an average of 8.33 days per trip. Statistics of the number of days absent from port during the year are presented by months, fishing grounds, and ports for all vessels, including otter trawlers, and for otter trawlers separately, in the following tables:

Days' absence from port of fishing vessels landing fish at Boston and Gloucester, Mass., and Portland, Me., 1925

Fishing grounds	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
BOSTON													
East of 66° W. longitude:													
La Have Bank	40			74	48	52	111	103	58	116	35	335	972
Western Bank	47	37	23	75	156	331	222	189	31	62	146	26	1,345
Quereau Bank				68	80	146	84	31	17	15			441
Green Bank				29									29
Grand Bank		25			36					35			96
St. Peters Bank		13		20	18								51
Burgeo Bank				57									57
Cape Shore	16				8	395		120	256	15	42	8	860
Gulf of St. Lawrence					52								52
The Gully		11	84	44									139
West of 66° W. longitude:													
Browns Bank	189	16	123	374	301	7	199	276	135	79	142	187	2,028
Georges Bank	393	766	986	322	519	670	1,308	798	364	331	58	15	6,530
Cashes Bank		6	4		14	17	5				15		61
Fippenies Bank											21		21
Middle Bank	54	83	91	18			41	105	83	148	79	42	744
German Bank							12						12
Jeffreys Ledge	912	79	79	6	20			104	93	66	325	185	1,149
South Channel	433	458	405	381	202	425	686	539	718	695	361	468	5,771
Nantucket Shoals	84			56	242	88	232	173	15	98	246	75	1,309
Off Chatham	50	37	94	31	19	16	63	460	91	136	14	48	1,059
Seal Island										15	8		23
Shore, general	163	210	349	1,046	362	666	430	379	513	367	237	291	5,013
Total	1,661	1,741	2,238	2,601	2,077	2,813	3,393	3,277	2,374	2,178	1,729	1,680	27,762
GLOUCESTER													
East of 66° W. longitude:													
La Have Bank				45	49	76	54	39	23				286
Western Bank		9	54	72	332	431	391	379	44	77			1,789
Quereau Bank		14			23	450	80		57				624
Green Bank			26	32									58
Grand Bank					27								27
St. Peters Bank		43	18				58						119
Burgeo Bank				57									57
Off Newfoundland	89										97	246	432
Cape Shore						288							288
Gulf of St. Lawrence					23		29						52
Strait of Belle Isle						56							56
West of 66° W. longitude:													
Browns Bank			26	94	115		32	73	55		7		402
Georges Bank		175	400	193	363	201	293	376	454	*249			2,704
Middle Bank						15		390	594				999
Jeffreys Ledge								41					41
South Channel		10			34	90	102	66	44	70	6		422
Nantucket Shoals				12	9	11	17						49
Off Chatham								219					219
Seal Island				23									23
Shore, general	174	194	276	295	313	180	294	25	100	234	216	87	2,388
Total	263	445	800	823	1,288	1,798	1,350	1,608	1,371	630	326	333	11,035
PORTLAND													
East of 66° W. longitude:													
La Have Bank					14	16							30
Western Bank		30	27	89	117	52	87					14	416
Quereau Bank				27	22		22	97	21				189
Grand Bank						5							5
St. Peters Bank								29	22				51
Cape Shore								27	89				116
St. Anns Bank						22							22
The Gully							19		22				41
West of 66° W. longitude:													
Browns Bank		10	5				30	88	21				154
Georges Bank		7	28		11	11	220	41					318
Cashes Bank		6	21	53	25	10			8	2	33	9	167
Fippenies Bank	4	4	4	25			3			5	9	2	56
Middle Bank			2										2
Platts Bank	43	38		13	9		10		11	61	25	37	247
Jeffreys Ledge	27	36	36	40	37	9	7	86	45	69	85	48	525
South Channel		15		18		19							52
Nantucket Shoals					45								45
Seal Island			13		15	15		17		19			79
Shore, general	44	15	101	114	110	177	166	145	93	76	48	46	1,135
Total	118	161	237	379	405	336	564	530	332	232	200	156	3,650
Grand total	2,042	2,347	3,275	3,803	3,770	4,947	5,307	5,415	4,077	3,040	2,255	2,169	42,447

Days' absence from port of otter trawlers landing fish at Boston and Gloucester, Mass., and Portland, Me., 1925

Fishing grounds	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
BOSTON													
East of 66° W. longitude:													
Western Bank	47	37	23	70	43	20	25			36	139	26	466
West of 66° W. longitude:													
Georges Bank	168	142	255			8		27		31	10		641
South Channel	161	199	192	196	110	205	166	152	234	255	135	375	2,380
Nantucket Shoals	84			37	109	22	20			16	153	65	506
Off Chatham		19										6	25
Shore, general					9	8							17
Total	460	397	470	303	271	263	211	179	234	338	437	472	4,035
GLOUCESTER													
East of 66° W. longitude:													
Western Bank		9		50		14	36						109
West of 66° W. longitude:													
Georges Bank		8	67	26				50	40	8			199
South Channel		10			19	91	70	26	31	8			255
Nantucket Shoals				8	9	11	17						45
Total		27	67	84	28	116	123	76	71	16			608
PORTLAND													
East of 66° W. longitude:													
Western Bank		30	27	89	86	38						14	284
West of 66° W. longitude:													
Georges Bank		7	28										35
South Channel		15		18		19							52
Nantucket Shoals					45								45
Total		52	55	107	131	57						14	416
Grand total	460	476	592	494	430	436	334	255	305	354	437	486	5,059

VESSEL FISHERIES AT SEATTLE, WASH.

In the vessel fisheries at Seattle, Wash., in 1925, there was an increase, as compared with 1924, in the quantity and value of the products landed by the fishing fleet but a decrease in the quantity and value of products landed by collecting vessels. There was some falling off in the quantity and value of salmon and some other species not wholly compensated by the gains made by such species as herring, perch, "lingcod," sole, and crabs. Statistics of the vessel fisheries at Seattle were collected by the local agent and published as monthly and annual statistical bulletins giving the quantity and value of fishery products landed by American fishing and collecting vessels at that port.

In 1925 the fishing fleet at Seattle landed 838 trips, amounting to 12,996,550 pounds of fish having a value to the fishermen of $1,594,298. The catch was taken chiefly from fishing grounds along the coast from Oregon to Portlock Bank, Alaska. The largest quantities were taken from the Oregon coast, Flattery Banks, Hecate Strait, and Portlock Bank. The products included halibut, 9,685,050 pounds, valued at $1,403,167; sablefish, 2,340,200 pounds, valued at $160,499; "lingcod," 691,550 pounds, valued at $21,343; and rockfishes, 279,750 pounds, valued at $9,289. Compared with 1924 there was a decrease of 16 trips by fishing vessels, but an increase of 2,930,540 pounds, or 29.11 per cent, in the quantity, and of $264,341, or 19.88 per cent, in the value of the products landed.

The fishery products taken in Puget Sound and landed at Seattle by collecting vessels during the year amounted to 17,397,910 pounds, valued at $1,361,519. The products landed included salmon, 15,331,-

500 pounds, valued at $1,263,748; herring, 589,000 pounds, valued at $3,965; sturgeon, 10,100 pounds, valued at $1,694; steelhead trout, 54,350 pounds, valued at $4,575; smelt, 201,500 pounds, valued at $18,020; perch, 91,100 pounds, valued at $6,494; rockfishes, 95,810 pounds, valued at $4,840; "lingcod," 106,000 pounds, valued at $4,852; flounders, 77,150 pounds, valued at $1,973; sole, 296,800 pounds, valued at $13,170; and crabs, 544,600 pounds, valued at $38,188. Compared with 1924, there was a decrease in the products landed by collecting vessels of 768,800 pounds, or 4.23 per cent, in quantity and $27,746, or 2 per cent, in value. The quantity and value of fishery products landed at Seattle by fishing and collecting vessels in 1925 are given in detail in the following tables.

Statement, by fishing grounds and months, of quantities and values of certain fresh fishery products landed at Seattle, Wash., by American fishing vessels 1925

	Trips	Halibut		Sablefish	
FISHING GROUNDS		*Pounds*	*Value*	*Pounds*	*Value*
Oregon coast	59	503,700	$92,270	625,500	$44,970
Flattery Banks	337	1,711,400	289,510	1,334,300	90,049
Hecate Strait	404	5,882,150	841,967	358,400	23,960
Forrester Island grounds	1	85,000	8,500		
Coronation Island	1			20,000	1,400
Yakutat grounds	11	248,800	40,040	2,000	120
Portlock Bank	25	1,254,000	130,880		
Total	838	9,685,050	1,403,167	2,340,200	160,499
MONTHS					
January	3				
February	14	139,550	18,929	4,800	240
March	95	1,094,100	133,190	10,000	505
April	126	1,110,700	151,495	17,800	980
May	109	1,420,600	173,429	1,300	80
June	109	1,117,200	164,879	344,600	23,169
July	75	1,118,050	166,755	227,400	12,965
August	78	1,233,600	183,390	272,900	17,000
September	81	1,197,600	172,711	448,300	27,143
October	77	722,900	145,535	572,400	44,650
November	67	530,750	92,854	420,700	32,367
December	4			20,000	1,400
Total	838	9,685,050	1,403,167	2,340,200	160,499

	"Lingcod"		Rockfishes		Total	
FISHING GROUNDS	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Oregon coast	41,000	$1,245	21,500	$995	1,191,700	$139,480
Flattery Banks	442,250	14,242	157,750	5,189	3,645,700	398,990
Hecate Strait	208,300	5,856	98,000	2,930	6,546,850	874,713
Forrester Island grounds					85,000	8,500
Coronation Island			2,500	175	22,500	1,575
Yakutat grounds					250,800	40,160
Portlock Bank					1,254,000	130,880
Total	691,550	21,343	279,750	9,289	12,996,550	1,594,298
MONTHS						
January	12,000	985	6,000	491	18,000	1,476
February	44,000	1,874			188,350	21,043
March	67,700	1,951	29,300	830	1,201,100	136,476
April	129,000	2,888	37,000	860	1,294,500	156,223
May	75,700	2,206	40,000	990	1,537,600	176,705
June	64,000	1,920	35,000	1,050	1,560,800	191,018
July	39,000	1,035	27,000	775	1,411,450	181,530
August	40,700	1,241	20,500	855	1,567,700	202,486
September	77,100	2,318	31,000	930	1,754,000	203,102
October	93,800	2,854	33,700	1,475	1,422,800	194,514
November	42,300	1,513	12,500	400	1,006,250	127,134
December	6,250	558	7,750	633	34,000	2,591
Total	691,550	21,343	279,750	9,289	12,996,550	1,594,298

Fishery products, by months, taken in Puget Sound and landed at Seattle, Wash., by collecting vessels, 1925

Species	January		February		March		April		May	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Herring	120,000	$1,200	250,000	$1,250	35,000	$175	100,000	$500		
Smelt	38,500	3,850	12,000	960			16,000	1,600		
Perch	10,000	700	10,000	500	15,500	1,085	30,000	2,400		
Rockfishes	6,000	60	7,400	602	9,000	720	6,300	504	8,000	$560
"Lingcod"	48,000	3,360	8,000	240	4,600	184	6,500	130		
Flounders	6,800	136	7,000	140	6,000	120	23,000	920	6,000	90
Sole	84,000	3,360	37,000	2,960	24,300	972	15,000	600	15,000	600
Crabs	64,400	4,350	61,000	4,200	60,280	4,110	96,800	6,600	39,600	2,758
Total	377,700	17,016	392,400	10,852	154,680	7,366	293,600	13,254	68,600	4,008

Species	June		July		August		September	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Sturgeon	3,300	$330	800	$64	4,000	$900		
Salmon:								
Humpback or pink			18,400	736	16,600	332	61,000	$2,440
Chum or keta					14,000	270	24,500	1,020
King or spring	3,111,500	311,150	3,270,000	327,000	1,650,000	165,000	162,000	16,200
Coho or silver	152,900	7,645	160,500	8,025	446,000	17,840	2,250,000	157,500
Sockeye or red	23,000	2,300	19,600	1,960	51,000	5,100		
Trout, steelhead	21,500	1,290	12,400	1,240	14,000	1,400	6,450	645
Smelt					12,500	1,000	18,000	1,440
Perch					10,000	800	8,300	498
Rockfishes	4,150	205			14,600	830	12,800	190
"Lingcod"	6,000	120	16,000	320	8,900	178		
Flounders	9,400	188	9,000	180				
Sole					18,200	546	12,500	500
Crabs	5,900	405						
Total	3,337,650	323,633	3,506,700	339,525	2,259,800	194,196	2,555,550	180,433

Species	October		November		December		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Sturgeon	2,000	$400					10,100	$1,694
Herring					84,000	$840	589,000	3,965
Salmon:								
Humpback or pink							96,000	3,508
Chum or keta	1,540,000	61,600	330,000	$9,900			1,908,500	72,790
King or spring	122,000	14,600	22,500	2,250			8,338,000	836,200
Coho or silver	1,700,000	136,000	186,000	14,880			4,895,400	341,890
Sockeye or red							93,600	9,360
Trout, steelhead							54,350	4,575
Smelt	31,000	3,100	32,000	1,920	41,500	4,150	201,500	18,020
Perch					7,300	511	91,100	6,494
Rockfishes	7,000	210	12,400	496	8,160	463	95,810	4,840
"Lingcod"					8,000	320	106,000	4,852
Flounders	3,600	72	6,350	127			77,150	1,973
Sole	16,000	640	22,000	880	52,800	2,112	296,800	13,170
Crabs	73,400	5,000	87,120	5,940	56,100	4,825	[1] 544,600	38,188
Total	3,495,000	221,622	698,370	36,393	257,860	13,221	17,397,910	1,361,519

[1] 24,758 dozen.

FISHERY PRODUCTS RECEIVED AT MUNICIPAL FISH WHARF AND MARKET, WASHINGTON, D. C.[3]

The receipts of fishery products at the municipal fish wharf and market, Washington, D. C., in 1925, amounted to 7,041,058 pounds, a decrease of 966,646 pounds, or 12.07 per cent, as compared with 1924. The most important products, in quantity, were squeteagues or "sea trout," 1,412,358 pounds; croaker, 1,107,214 pounds; river

[3] Daily reports of the quantity of fishery products received at this market are furnished to the bureau for publication through the courtesy of the health department of the District of Columbia.

herring, 790,200 pounds; oysters, 480,052 pounds; shad, including roe, 436,475 pounds; haddock, 423,570 pounds; and striped bass, 330,074 pounds. The species ranking next in importance include butterfish, carp, catfish, flounders, halibut, mackerel, perch, spot, and crabs.

Fishery products, in pounds, received at municipal fish wharf and market, Washington, D. C., 1925

Species	January	February	March	April	May	June	July
Bass, black or sea	2,850	1,800	7,781	400	4,700	6,000	2,700
Bluefish			200		500	4,100	4,400
Bowfin	1,000						
Butterfish	2,400	800	700	5,200	27,900	73,200	65,600
Carp	4,250	17,900	12,972	14,300	22,800	8,700	4,700
Catfish	3,000	26,600	30,525	25,250	12,300	9,105	4,800
Ciscoes	100						
Cod:							
Fresh	3,900	7,175	5,400	4,200	3,000	4,800	4,200
Salted			200				
Crappie		400	200				
Crevalle		300	400				
Croaker	19,400	6,500	40,000	243,700	239,600	205,955	224,600
Eels		400	2,013	2,100	350	200	300
Flounders	11,100	26,000	39,380	14,300	12,800	15,100	12,600
Gizzard shad	18,300	13,700	1,400				
Haddock:							
Fresh	39,300	75,050	80,300	42,100	24,900	24,600	21,800
Smoked							
Hake							
Halibut	31,633	7,000	8,250	16,300	10,700	11,400	9,800
Herring:							
River	44,700	31,050	120,650	428,100	162,400	2,800	
Sea	22,000						
Hickory shad or "jacks"	9,600	5,200	5,625	3,800	800		
Kingfish	4,700	4,700	3,800	6,200	1,000	400	3,100
Mackerel	4,400	4,300	2,550	6,800	15,200	25,700	18,700
Menhaden		4,600	1,400				
Mullet	525	200					
Perch	6,850	30,050	43,680	22,565	14,400	5,500	3,740
Pigfish	1,300	1,100					
Pike or pickerel	200	3,475	600	220	100		100
Pollock		800	800		200	400	1,200
Pompano	400					200	
Redfish or red drum	3,200	3,400	800		900	600	
Red snapper	1,000	200	400	400	400	200	200
Salmon	5,500	2,100	3,200	500	400	2,700	2,400
Sergeantfish	200						
Scup or porgy		600			200	2,800	1,900
Shad	25,700	21,100	94,235	179,200	105,580	7,115	
Shad roe		45					
Sheepshead	400	100	200				
Skates							
Smelt							
Spot	4,105	725	350				
Squeteagues or "sea trout"	200	500		300	500	5,100	47,000
Squid	25,800	12,400	7,100	40,400	242,500	174,400	188,800
Striped bass					400	200	
Sturgeon	4,000	6,850	32,593	44,370	23,700	31,000	30,500
Sturgeon caviar	100	300			100	115	850
Swordfish							17
Tilefish						150	700
Whiting	100	500	500	500	200		
Clams, hard	8,800		1,200		400		
Oysters:	1,728	3,552	3,808	4,448	6,752	9,600	8,736
In the shell	29,729	47,208	30,205	6,370	224	88	
Opened	41,332	27,448	23,430	1,774			
Scallops	720		1,280	160	400	5,040	640
Crabs			720	405	1,785	13,800	53,805
Crab meat	110	115	400	1,785	4,450	16,665	18,015
Frogs		13	30	150	85	94	
Lobster	100	200	200	400	650	300	200
Shrimp	1,200	1,200	1,400	2,500	4,700	5,000	5,100
Turtles	1,200	418	154	454	1,258	428	146
Total	387,132	398,074	611,031	1,119,651	949,234	673,555	741,349

Fishery products, in pounds, received at municipal fish wharf and market, Washington, D. C., 1925—Continued

Species	August	September	October	November	December	Total
Bass, black or sea	4,300	700	2,300	6,500	3,230	43,261
Bluefish	9,155	10,500	13,680		4,000	46,535
Bowfin						1,000
Butterfish	27,225	26,400	23,600	800	6,750	260,575
Carp	1,851	1,311	12,710	4,990	5,140	111,624
Catfish	303	6,900	15,050	14,760	15,135	163,728
Ciscoes						100
Cod:						
Fresh	5,800	3,500	5,200	3,700	600	51,475
Salted						200
Crappie						600
Crevalle						700
Croaker	58,009	25,900	11,900	17,450	14,200	1,107,214
Eels			750	1,180	625	7,918
Flounders	11,608	12,700	9,600	8,200	12,000	185,388
Gizzard shad				2,750	7,000	43,150
Haddock:						
Fresh	9,900	20,500	32,380	43,860	6,500	421,190
Smoked	2,380					2,380
Hake			13,600	29,400	2,600	45,600
Halibut	4,200	8,400	15,000	8,400	600	131,683
Herring:						
River			500			790,200
Sea						22,000
Hickory shad or "jacks"						25,025
Kingfish	100		900	200	1,850	26,950
Mackerel	17,312	33,100	28,500	12,350	8,000	176,912
Menhaden						6,000
Mullet		200	650	2,480	149	4,204
Perch	5,001	4,800	8,650	6,375	8,850	160,461
Pigfish						2,400
Pike or pickerel		200	2,150	3,300	1,180	11,525
Pollock	1,200	3,800	3,200	3,000	10,200	24,800
Pompano						600
Redfish or red drum			300	1,650	600	11,450
Red snapper						2,800
Salmon	2,384	1,850	3,200	1,450	200	25,884
Sergeantfish						200
Scup or porgy	200					5,700
Shad			900	2,000	600	436,430
Shad roe						45
Sheepshead						700
Skates				200		200
Smelt				400	500	6,080
Spot	1,500	7,300	28,900	3,250	6,900	101,450
Squeteagues or "sea trout"	173,908	237,600	171,450	75,900	62,100	1,412,358
Squid					125	725
Striped bass	18,501	38,300	63,000	25,815	11,445	330,074
Sturgeon						1,465
Sturgeon caviar						17
Swordfish						850
Tilefish						1,800
Whiting			2,800	4,805	10,600	28,605
Clams, hard	6,272	5,408	3,584	1,728	1,504	[1] 57,120
Oysters:						
In the shell		791	31,556	35,385	38,150	[2] 219,706
Opened		8,803	57,907	56,133	43,519	[3] 260,346
Scallops	80					8,320
Crabs	46,125	4,830	10,425			131,895
Crab meat	11,730	14,725	4,750	1,170	50	73,965
Frogs						372
Lobster		50		25	2,000	4,125
Shrimp	6,300	6,700	3,200	1,600	20	38,920
Turtles						4,058
Total	425,344	485,268	582,292	381,206	286,922	7,041,058

[1] 7,140 bushels. [2] 31,387 bushels. [3] 3,156 bushels.

NOTE.—The clams have been reduced to pounds on the basis of 8 pounds of meat to a bushel; the oysters on the basis of 7 pounds of meat to a bushel and 8¼ pounds to a gallon.

SHAD AND ALEWIFE FISHERY OF THE POTOMAC RIVER

The regular annual statistics of the shad and alewife fisheries of the Potomac River were taken for the season 1925. They show that the shad fishery yielded 204,582 shad that weighed 696,632 pounds, valued at $163,398 to the fishermen. While this is an increase over 1924 of 19 per cent in number, 21 per cent in pounds, and 85 per cent in value, it marks one of the lowest catches upon which statistics are available.

The catch of alewives, amounting to 7,835,380 fish, with a weight of 3,134,152 pounds, valued at $37,341 to the fishermen, was less than the 1924 catch by 48 per cent in number and 34 per cent in value, and was the smallest catch since 1915.

The following tables give detailed statistics for 1925 and comparative statistics on the shad and alewife catches in the Potomac River for the years for which statistics are available.

Shad and alewife fisheries of the Potomac River, 1925

Item	Maryland			Virginia			Total		
	Number	*Pounds*	*Value*	*Number*	*Pounds*	*Value*	*Number*	*Pounds*	*Value*
Fishermen	269			492			761		
Rowboats and scows	94		$3,435	183		$6,590	277		$10,025
Gasoline boats	61		15,095	198		65,520	259		80,615
Pound nets	101		15,325	287		103,225	388		118,550
Gill nets	87		7,400	274		8,375	361		15,775
Haul seines	1		1,500				1		1,500
Shore and accessory property			1,000						1,000
Total			43,755			183,710			227,465
Shad caught:									
With pound nets	5,947	20,076	4,541	134,148	451,889	107,174	140,095	471,965	111,715
With gill nets	34,711	122,635	28,281	24,426	86,957	20,914	59,137	209,592	49,195
With haul seines	5,350	15,075	2,488				5,350	15,075	2,488
Total	46,008	157,786	35,310	158,574	538,846	128,088	204,582	696,632	163,398
Alewives caught:									
With pound nets	315,000	126,000	1,670	7,365,380	2,946,152	34,496	7,680,280	3,072,152	36,166
With gill nets				55,000	22,000	775	55,000	22,000	775
With haul seines	100,000	40,000	400				100,000	40,000	400
Total	415,000	166,000	2,070	7,420,380	2,968,152	35,271	7,835,380	3,134,152	37,341

Production of shad in the Potomac River in various years, 1896 to 1925

Year	Maryland			Virginia			Total		
	Number	*Pounds*	*Value*	*Number*	*Pounds*	*Value*	*Number*	*Pounds*	*Value*
1925	46,008	157,786	$35,310	158,574	538,846	$128,088	204,582	696,632	$163,398
1924	37,505	127,285	20,469	134,805	450,925	67,981	172,310	578,210	88,450
1923	93,619	308,729	52,917	257,927	878,653	145,702	351,546	1,187,382	198,619
1922	203,682	706,501	95,140	680,494	2,409,070	324,882	884,176	3,115,571	420,022
1921	49,681	138,207	25,191	356,191	1,022,231	182,179	405,872	1,160,438	207,370
1920	80,944	302,237	55,963	448,414	1,677,543	278,501	529,358	1,979,780	334,464
1919	94,512	354,420	56,833	449,957	1,687,339	275,564	544,469	2,041,759	332,397
1915	17,196	64,485	6,827	165,206	619,523	65,300	182,402	684,008	72,127
1909	31,158	116,843	9,232	172,813	648,049	44,500	203,971	764,892	53,732
1904	83,147	311,801	16,343	289,500	1,085,625	51,709	372,647	1,397,426	68,052
1901	146,000	547,500	14,800	648,462	2,431,733	104,566	794,462	2,979,233	119,366
1896	233,238	874,643	20,524	450,825	1,690,594	43,084	684,063	2,565,237	63,608

Production of alewives in the Potomac River in various years, 1909 to 1925

Year	Maryland			Virginia			Total		
	Number	*Pounds*	*Value*	*Number*	*Pounds*	*Value*	*Number*	*Pounds*	*Value*
1925	415,000	166,000	$2,070	7,420,380	2,968,152	$35,271	7,835,380	3,134,152	$37,341
1924	1,834,000	733,600	6,885	13,299,388	5,319,156	49,667	15,133,388	6,052,756	56,552
1923	2,119,787	847,916	8,764	9,308,782	3,722,912	40,657	11,428,569	4,570,828	49,421
1922	1,292,500	517,000	3,700	10,074,500	4,029,800	34,642	11,367,000	4,546,800	38,342
1921	1,395,000	558,000	9,010	8,908,510	3,563,404	35,031	10,303,510	4,121,404	44,041
1920	1,077,775	538,888	13,940	7,681,561	3,813,780	41,197	8,759,336	4,352,668	55,137
1919	1,488,583	772,867	15,508	7,379,319	2,904,054	45,508	8,867,902	3,676,921	61,016
1915	335,000	----------	1,420	7,276,428	----------	30,741	7,611,428	----------	32,161
1909	4,883,000	----------	10,369	24,601,040	----------	42,854	29,484,040	----------	53,223

SHAD FISHERY OF THE HUDSON RIVER

In 1923 there were 213 persons engaged in the shad fishery of the Hudson River in New York and New Jersey. The investment amounted to $27,629, and 35,086 shad, or 121,728 pounds were caught, valued at $28.644. Of this quantity 28,636 shad, or 97,863 pounds, valued at $22,644, were taken in New York, and 6,450, or 23,865 pounds, valued at $6,000, in New Jersey.

In 1924 there were 184 persons engaged in this fishery. The investment amounted to $22.838, and 28,794 shad, or 94,369 pounds, valued at $23,104, were caught. The catch in New York amounted to 22,814 shad, or 72,519 pounds, valued at $17,619, and in New Jersey to 5,980 fish, or 21,850 pounds, valued at $5,485.

Compared with 1922, there was a decrease in 1923 of 59 in the number of persons engaged, $12,713 in the investment, and 13,250 in the number of shad taken (or 53,458 pounds), and of $11,052 in the value. In 1924, as compared with 1922, there was a decrease of 88 persons, $17,504 in the investment, and 19,542 in the number of shad taken (or 80,817 pounds), and of $16,602 in the value. The number of persons engaged, the investment, and catch also were considerably smaller in 1924 than in the previous year. The statistics for 1923 and 1924 and comparative statistics of the catch from 1915 to 1924, inclusive, are given in the following tables:

Shad fishery of the Hudson River, 1923 and 1924

Item	1923								
	New York			New Jersey			Total		
	Number	*Pounds*	*Value*	*Number*	*Pounds*	*Value*	*Number*	*Pounds*	*Value*
Fishermen	203	----------	----------	10	----------	----------	213	----------	----------
Rowboats and scows	85	----------	$4,475	9	----------	$1,375	94	----------	$5,850
Gasoline boats	17	----------	2,947	3	----------	1,400	20	----------	4,347
Gill nets, drift	110	----------	10,597	----------	----------	----------	110	----------	10,597
Gill nets, stake	----------	----------	----------	5	----------	1,250	5	----------	1,250
Haul seines	2	----------	285	----------	----------	----------	2	----------	285
Shore and accessory property	----------	----------	4,900	----------	----------	400	----------	----------	5,300
Total	----------	----------	23,204	----------	----------	4,425	----------	----------	27,629
Shad caught:									
With drift gill nets	27,245	93,503	21,665	----------	----------	----------	27,245	93,503	21,665
With stake gill nets	----------	----------	----------	6,450	23,865	6,000	6,450	23,865	6,000
With haul seines	669	2,100	450	----------	----------	----------	669	2,100	450
With other apparatus, incidentally	722	2,260	529	----------	----------	----------	722	2,260	529
Total	28,636	97,863	22,644	6,450	23,865	6,000	35,086	121,728	28,644

Shad fishery of the Hudson River, 1923 and 1924—Continued

Item	1924								
	New York			New Jersey			Total		
	Number	*Pounds*	*Value*	*Number*	*Pounds*	*Value*	*Number*	*Pounds*	*Value*
Fishermen	176			8			184		
Rowboats and scows	80		$3,865	8		$1,340	88		$5,205
Gasoline boats	17		2,830	3		1,400	20		4,230
Gill nets, drift	95		7,733				95		7,733
Gill nets, stake				4		1,000	4		1,000
Haul seines	2		245				2		245
Shore and accessory property			4,095			330			4,425
Total			18,768			4,070			22,838
Shad caught:									
With drift gill nets	22,002	70,159	17,086				22,002	70,159	17,086
With stake gill nets				5,980	21,850	5,485	5,980	21,850	5,485
With haul seines	625	1,760	380				625	1,760	380
With other apparatus, incidentally	187	600	153				187	600	153
Total	22,814	72,519	17,619	5,980	21,850	5,485	28,794	94,369	23,104

Comparative statistics of the shad fishery of the Hudson River, 1915 to 1924

Year	New York			New Jersey			Total		
	Number	*Pounds*	*Value*	*Number*	*Pounds*	*Value*	*Number*	*Pounds*	*Value*
1915	11,606	48,564	$5,969	4,249	20,104	$2,674	15,855	68,668	$8,643
1916	7,787	32,923	4,540	1,500	7,250	925	9,287	40,173	5,465
1917	10,615	38,344	5,810	1,400	5,040	720	12,015	43,384	6,540
1918	63,404	220,602	44,784	3,999	14,000	3,400	67,403	234,602	48,184
1919	76,501	301,306	60,690	13,800	73,668	23,034	90,301	374,974	83,724
1920	39,692	157,715	43,882	9,623	42,129	12,427	49,315	199,844	56,309
1921	28,948	104,883	24,329	6,500	25,920	6,294	35,448	130,803	30,623
1922	36,111	128,324	27,451	12,225	46,862	12,255	48,336	175,186	39,706
1923	28,636	97,863	22,644	6,450	23,865	6,000	35,086	121,728	28,644
1924	22,814	72,519	17,619	5,980	21,850	5,485	28,794	94,369	23,104

FLORIDA SPONGE FISHERY

In 1925 the quantity of sponges sold at the Sponge Exchange, Tarpon Springs, Fla., was 434,672 pounds, valued at $715,097, of which 242,020 pounds, valued at $609,393, were large wool; 29,968 pounds, valued at $44,952, were small wool; 120,748 pounds, valued at $48,300, yellow; 28,622 pounds, valued at $8,014, grass; and 13,314 pounds, valued at $4,438, wire. It is estimated that sponges to the value of $50,000 were sold outside the exchange at Tarpon Springs.

Compared with the production of 1924, this is an increase of 2 per cent in total quantity and less than 1 per cent in total value. When compared with the annual production in the years 1919 to 1924, it is apparent that the production for 1925 continued to be slightly below normal in quantity and above normal in value. The production of large wool sponges was below that for 1924 but compared favorably with 1919–1923. The production of small wool sponges decreased by almost half for the same period, while that of yellow sponges increased by about half. The production of grass sponges showed a gratifying increase over 1924, though it was con-

siderably less than previous years. The production of wire sponges also showed a marked increase and exceeded that of any year from 1919 to 1924, except 1923.

Sponges sold at the exchange, Tarpon Springs, Fla., 1919 to 1925

Year	Total		Large wool	Small wool	Yellow	Grass	Wire
	Pounds	*Value*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
1925	434,672	$715,097	242,020	29,968	120,748	28,622	13,314
1924	425,305	714,760	265,392	58,021	81,420	14,898	5,574
1923	490,200	734,391	243,230	54,292	87,878	88,772	16,028
1922	526,885	699,089	248,475	70,478	115,455	84,892	7,585
1921	386,390	540,093	173,723	63,786	70,218	65,745	12,918
1920	409,746	678,209	176,722	60,902	72,648	92,880	6,594
1919	424,075	707,964	205,462	76,309	73,051	62,547	6,706

FISHERIES OF THE GULF STATES, 1923

The statistics contained in this report apply to the commercial coast fisheries of the western coast of Florida, Alabama, Mississippi, Louisiana, and Texas, and are for the year 1923. The canvass of the fisheries was made by Rob Leon Greer and Carl B. Tendick, agents of this bureau, with the assistance of temporary employees. It is desired to thank the respective State fisheries officials for their kindness in making their records available to these agents and in otherwise cooperating to facilitate the acquisition of information in this canvass.

The canvass, in so far as possible, was conducted similarly to that of the fisheries of the Gulf States in 1918, in order that the statistics might be comparable.[4]

In the interests of economy and simplicity detailed statistics for separate counties, hitherto published, have been omitted from this report. The various tabulations for each county are on file, however, and will be made available to investigators and other persons upon request.

EARLIER PUBLICATIONS

Some of the earlier publications relating to the fisheries of the Gulf States, published in Washington, D. C., are as follows:

Fisheries of the Gulf of Mexico, by Silas Stearns. *In* The Fisheries and Fishery Industries of the United States, 1887, Section II, pp. 533–587.

A Statistical Report on the Fisheries of the Gulf States, by J. W. Collins and H. M. Smith. Bulletin, U. S. Fish Commission, 1891, pp. 91–184.

Report on the Coast Fisheries of Texas, by Charles H. Stevenson. Appendix, Report, U. S. Commissioner of Fish and Fisheries, 1889–1891, pp. 373–420, pls. 13–27.

[4] The statistical reports published by the Bureau of Fisheries on the fisheries of the coastal States include the commercial fisheries of the ocean, bays, and estuaries bordering the States and also the river fisheries up as far from tidewater as the anadromous fishes are commercially important. The statistics are for the calendar year, excepting those of the oyster yield, which are for the season ending during the calendar year. The products shown as yield of the fisheries are those produced and marketed by fishermen, and the values are based on the prices paid to the fishermen. Where vessels and boats are shown separately, vessels are all craft of 5 net tons and upward as measured by the United States Customs Service, and boats are all craft under 5 net tons. The "vessel fisheries" are those prosecuted by vessels defined as above, and the shore fisheries are those prosecuted by boats as defined above or without employment of water craft. The statistics are credited to the county and State in which the fisherman makes his home port. In some cases this may be distant from the place where the fish are caught and marketed, but usually the fish are caught in the waters contiguous to and marketed in the county and State to which they are credited.

The Fish and Fisheries of the Coastal Waters of Florida. Transmitted to the United States Senate by the Commissioner of Fish and Fisheries, January 28, 1897. Senate Document 100, Fifty-fourth Congress, second session. See also, pp. 263–342, Appendix, Report, U. S. Commissioner of Fish and Fisheries, 1896.

Statistics of the Fisheries of the Gulf States, by C. H. Townsend. Report, U. S. Commissioner of Fish and Fisheries, 1899, pp. 105–169.

Statistics of the Fisheries of the Gulf States, 1902. Appendix, Report, U. S. Commissioner of Fish and Fisheries, 1903, pp. 411–481.

Fisheries of the United States, 1908. Special Reports, Bureau of the Census, 1911.

Fisheries of the Gulf States in 1918. *In* Fisheries Industries of the United States, by Lewis Radcliffe. Appendix X, Report, U. S. Commissioner of Fisheries, 1919, pp. 129–191, Bureau of Fisheries, Document No. 892.

Fisheries of Key West and the Clam Industry of Southern Florida, by William C. Schroeder. Appendix XII, Report, U. S. Commissioner of Fisheries, 1923. Bureau of Fisheries, Document No. 962.

COMMON AND SCIENTIFIC NAMES OF FISHES

In order to prevent misunderstanding from the use of common names employed in the tables and discussions, the following list of common and scientific names is given:

Amberfish	Seriola (species).
Angelfish	*Chætodipterus faber.*
Barracuda	Sphyræna (species).
Bluefish	*Pomatomus saltatrix.*
Blue runner or hardtail	*Caranx crysos.*
Bonito	*Sarda sarda.*
Catfish	*Felichthys marinus.* *Galeichthys felis.*
Cero and kingfish	*Scomberomorus regalis.* *Scomberomorus cavalla.*
Crevallé	Caranx (species).
Croaker	*Micropogon undulatus.*
Drum, black	*Pogonias cromis.*
Drum, red, or redfish	*Sciænops ocellatus.*
Elops or ten-pounder	*Elops saurus.*
Flounders	Pleuronectidæ (species).
Groupers	Epinephelus (species). Mycteroperca (species). *Garrupta nigrita.*
Grunts	Hæmulidæ (species).
Harvestfish or "butterfish"	*Peprilus alepidotus.*
Hogfish	*Lachnolaimus maximus.*
Jewfish	*Promicrops guttatus.*
King whiting	Menticirrhus (species).
Leather jacket or "turbot"	*Balistes carolinensis.*
Menhaden	Brevoortia tyrannus.
Moonfish	*Vomer setipinnis.*
Mullet	*Mugil cephalus.* *Mugil curema.*
Permit	*Trachinotus goodei.*
Pigfish	*Orthopristis chrysopterus.*
Pinfish or sailor's choice	*Lagodon rhomboides.* Other species.
Pompano	*Trachinotus carolinus.* Trachinotus (other species). (See also Permit).
Porgies	Calamus (species). Pagrus (species).
Porkfish	*Anisotremus virginicus.*
Sawfish	Pristis (species).
Sea bass	*Centropristes striatus.*

Sea gar	Tylosurus (species).
Sergeantfish or snook	*Centropomus undecimalis.*
Sharks	All Selachii except Batoidei.
Sheepshead	*Archosargus probatocephalus.*
Snapper, mangrove	*Lutianus griseus.*
Snapper, mutton	*Lutianus analis.*
Snapper, red	*Lutianus blackfordi.*
Spanish mackerel	*Scomberomorus maculatus.*
Spot	*Leiostomus xanthurus.*
Squeteagues or "sea trout"	Cynoscion (species).
Sturgeon	*Acipenser sturio.*
Tang	Teuthididæ (species).
Yellowtail	*Ocyurus chrysurus.*

GENERAL STATISTICS

The fisheries and fishery industries of the Gulf States in 1923 gave employment to 17,793 persons, of whom 11,132 were engaged in fishing operations, 1,785 in the wholesale trade, and 4,876 in the fish canning and by-products industries. The investment amounted to $10,535,905. Of this amount $5,196,541 was invested in vessels, boats, gear, and shore property used by fishermen, $1,975,223 in property and cash capital of the wholesale fish business, and $3,364,141 in property and cash capital of the canning and by-products industries. The yield of the fisheries aggregated 160,324,042 pounds, valued at $8,096,650. The output of the canning and by-products industries was valued at $6,264,913.

The west coast of Florida was foremost among the Gulf States in the importance of her fisheries with 5,827 persons employed $4,160,511 invested, and a production of 73,266,267 pounds of fishery products, valued at $4,026,227. Louisiana was next, with 5,158 persons employed, $2,606,297 invested, and a production of 34,835,194 pounds, valued at $1,961,100. Mississippi, Texas, and Alabama followed in the order named.

Based on value to the fishermen, shrimp, with a production of 44,246,177 pounds, valued at $1,735,422, was the most important of the Gulf States fishery products, constituting 21.4 per cent of the total value. Others, named in order of value, were oysters, 25,453,309 pounds, or 3,636,187 bushels, valued at $1,587,945; mullet, 30,797,824 pounds, valued at $1,207,114; sponges, 574,593 pounds, valued at $873,572; red snapper, 11,728,845 pounds, valued at $864,857; and squeteagues or "sea trout," 4,356,906 pounds, valued at $426,668. Red drum, clams, menhaden, and groupers, with values between $100,000 and $200,000, were next in order, and the remaining 47 varieties of fishery products aggregated 11,454,402 pounds, valued at $461,469, and constituted less than 6 per cent of the total production.

Compared with 1918, there was an increase of 2,905, or 19.5 per cent, in the number of persons engaged: $3,998,046 or 61.2 per cent in the amount of capital invested; 29,400,459 pounds, or 22.5 per cent, in the quantity of fishery products landed by fishermen; and $1,586,340, or 24.4 per cent in the value of these products. A large portion of this increase resulted from the growth of the shrimp-canning industry. In fact, the shrimp industries' remarkable growth was the outstanding feature of conditions revealed by the 1923 statistics.

Fisheries of the Gulf States, 1923

Item	Florida (west coast)		Alabama		Mississippi	
PERSONS ENGAGED	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*
On vessels fishing	782		88		712	
On vessels transporting	97		34		46	
In shore fisheries	3,758		446		942	
Shoresmen	217					
Total	4,854		568		1,700	
INVESTMENT						
Vessels fishing:						
Gasoline	52	$336,521	17	$57,485	34	$51,430
Tonnage	1,026		250		344	
Outfit		103,825		16,425		4,767
Sail	46	387,355			109	208,055
Tonnage	1,614				1,648	
Outfit		104,015				17,261
Vessels transporting:						
Gasoline	24	99,635	13	22,130	7	9,900
Tonnage	314		112		75	
Outfit		19,300		1,435		780
Sail	14	14,720	1	4,000	7	12,600
Tonnage	257		35		143	
Outfit		3,250		185		810
Boats, power	1,289	642,038	196	165,150	378	275,550
Boats, sail	145	24,180			1	250
Boats, row	1,605	54,865	225	4,405	479	11,230
Apparatus, vessel fisheries:						
Purse seines	8	7,200				
Haul seines					69	28,450
Trammel nets			1	100		
Gill nets	6	300				
Lines		6,183		970		
Otter trawls	4	175	8	360	24	975
Dip nets	2	3				
Dredges					248	4,370
Tongs	10	92			20	192
Sponge apparatus		206				
Apparatus, shore fisheries:						
Hall seines	159	45,250	7	1,600	20	6,160
Trammel nets	193	18,160	59	4,660	79	9,625
Gill nets	2,041	121,620				
Pound nets	13	24,000				
Fyke nets	360	720				
Stop nets	133	7,120				
Cast nets					50	500
Spears	2	4			32	23
Lines		2,217		64		776
Otter trawls	104	4,000	139	5,620	276	10,640
Dip nets	28	28			25	19
Crawfish traps	54	108				
Dredges	2	47,000			80	1,555
Tongs	293	2,682	387	3,206	400	3,205
Sponge apparatus		35,540				
Shore and accessory property		159,426		7,625		17,450
Total		2,271,738		295,420		676,573

Fisheries of the Gulf States, 1923—Continued

Item	Louisiana		Texas		Total	
PERSONS ENGAGED	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*
On vessels fishing	144		261		1,987	
On vessels transporting	146		16		339	
In shore fisheries	2,321		1,122		8,589	
Shoresmen					217	
Total	2,611		1,399		11,132	
INVESTMENT						
Vessels fishing:						
Steam			2	$30,000	2	$30,000
Tonnage			217		217	
Outfit				8,800		8,800
Gasoline	59	$109,100	19	125,000	181	679,536
Tonnage	394		292		2,306	
Outfit		15,046		9,695		149,758
Sail			11	74,900	166	670,310
Tonnage			288		3,550	
Outfit				16,305		137,581
Vessels transporting:						
Steam	1	7,500			1	7,500
Tonnage	18				18	
Outfit		3,600				3,600
Gasoline	70	141,600	2	2,250	116	275,515
Tonnage	546		16		1,063	
Outfit		6,470		170		28,155
Sail			4	1,600	26	32,920
Tonnage			23		458	
Outfit				270		4,515
Boats, power	1,141	919,400	250	135,400	3,254	2,137,538
Boats, sail			115	59,300	261	83,730
Boats, row	577	18,310	408	12,250	3,294	101,060
Apparatus, vessel fisheries:						
Purse seines			5	8,500	13	15,700
Haul seines			4	890	73	29,340
Trammel nets			1	175	2	275
Gill nets					6	300
Lines				845		7,998
Otter trawls	46	1,850	4	150	86	3,510
Dip nets					2	3
Dredges	20	585	6	140	274	5,095
Tongs	13	94	25	198	68	576
Sponge apparatus						206
Apparatus, shore fisheries:						
Haul seines	246	53,330	166	39,735	598	146,075
Trammel nets	87	13,000	67	11,660	485	57,105
Gill nets			347	6,710	2,388	128,330
Pound nets					13	24,000
Fyke nets					360	720
Stop nets					133	7,120
Cast nets	10	80			60	580
Spears			142	94	176	121
Lines		954		542		4,553
Otter trawls	765	29,940	80	3,200	1,364	53,400
Dip nets	700	280			753	327
Crawfish traps					54	108
Dredges	17	480	21	525	120	49,560
Tongs	504	3,297	328	2,710	1,912	15,100
Sponge apparatus						35,540
Shore and accessory property		60,780		15,100		260,381
Total		1,385,696		567,114		5,196,541

Fisheries of the Gulf States, 1923—Continued

Item	Florida (west coast)		Alabama		Mississippi	
PRODUCTS	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Amberfish	13,845	$322				
Angelfish	28,664	915	1,940	$72		
Barracuda	1,600	64				
Bluefish	417,840	39,025	3,500	210	5,900	$414
Blue runner or hardtail	351,968	16,176	1,200	36		
Bonito	28,030	1,010				
Catfish	114,780	5,313	16,220	638	35,440	1,278
Cero and kingfish	564,128	38,086				
Crevalle	156,084	4,618				
Croaker			26,600	1,115	45,015	1,881
Drum, black	95,294	2,878	9,250	279	38,989	1,263
Drum, red, or redfish	1,398,291	43,249	14,765	949	176,760	12,979
Elops or ten-pounder	353,736	10,628				
Flounders	71,315	3,936	2,190	178	87,616	8,919
Groupers	4,265,569	110,689	304,600	7,615	26,137	784
Grunts	94,867	2,846	2,975	73		
Harvestfish or "butterfish"	1,000	45				
Hogfish	9,448	284				
Jewfish	109,188	2,565			5,200	156
King whiting	77,021	5,574	2,598	134	9,054	541
Leather jacket or "turbot"	1,450	53				
Menhaden	10,955,825	78,303			400	20
Moonfish	775	22				
Mullet, fresh	27,741,837	1,091,383	648,200	22,473	1,739,026	52,719
Mullet, salted	445,023	30,624				
Mullet roe, fresh	13,945	1,653				
Mullet roe, salted	20,765	1,836				
Permit	8,493	266				
Pigfish	6,156	179				
Pinfish or sailor's choice	77,390	2,333				
Pompano, fresh	280,403	51,446	770	159	7,156	1,462
Pompano, salted	1,000	100				
Porgies	28,600	1,180			400	12
Porkfish	2,500	138				
Sawfish	200,000	2,500				
Sea bass	25,100	2,450			7,940	595
Sergeantfish or snook	103,701	3,184				
Sharks	3,000,000	24,000				
Sheepshead	1,025,415	31,963	20,640	1,389	90,768	5,771
Snapper, mangrove	125,179	4,221				
Snapper, mutton	28,225	1,013				
Snapper, red	9,471,267	680,232	970,000	77,600	103,618	8,808
Spanish mackerel	3,772,028	308,829	1,185	119	10,082	966
Spot	55,929	1,677	15,760	486	27,245	912
Squeteagues or "sea trout"	1,590,523	157,169	48,910	4,903	410,294	37,327
Sturgeon	7,400	1,088				
Sturgeon caviar	25	25				
Tang	600	24				
Yellowtail	38,672	2,422				
Crabs, hard			84,000	2,750	434,644	11,431
Crabs, soft					8,800	2,180
Crabs, stone	7,200	1,200				
Sea crawfish or spiny lobster	321,010	16,051				
Shrimp, green	2,881,454	114,509	3,182,000	119,239	9,879,100	359,086
Clams, hard	602,272	180,040				
Conchs	2,500	50				
Oysters, market, public	1,642,144	68,564	906,227	32,751	9,046,002	362,347
Oysters, market, private			725,375	53,968	2,828,952	110,305
Oysters, seed, public			630,000	13,500		
Terrapin			2,332	933	7,200	3,585
Turtles	54,200	3,705				
Sponges, grass	97,277	18,059				
Sponges, sheepswool	339,623	778,949				
Sponges, wire	16,028	7,479				
Sponges, yellow	121,665	69,085				
Total	73,266,267	4,026,227	7,631,237	341,569	25,031,738	985,741

Fisheries of the Gulf States, 1923—Continued

Item	Louisiana		Texas		Total	
PRODUCTS	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Amberfish					13,845	$322
Angelfish					30,604	987
Barracuda					1,600	64
Bluefish			500	$85	427,740	39,734
Blue runner or hardtail					353,168	16,212
Bonito					28,030	1,010
Catfish	104,735	$3,931	50,340	2,614	321,515	13,774
Cero and kingfish					564,128	38,086
Crevalle					156,084	4,618
Croaker	219,025	12,554	67,970	3,288	368,610	18,838
Drum, black	59,988	2,000	1,028,451	36,807	1,231,972	43,227
Drum, red, or redfish	665,067	55,941	877,760	72,299	3,132,643	185,417
Elops or ten-pounder					353,736	10,628
Flounders	21,513	1,890	118,395	10,203	301,029	25,126
Groupers	10,000	500	32,725	980	4,639,031	120,568
Grunts					97,842	2,919
Harvestfish or "butterfish"					1,000	45
Hogfish					9,448	284
Jewfish			13,450	553	127,838	3,274
King whiting			11,403	1,015	100,076	7,264
Leather jacket or "turbot"					1,450	53
Menhaden			8,517,000	56,780	19,473,225	135,103
Moonfish					775	22
Mullet, fresh	181,485	6,152	7,543	274	30,318,091	1,173,001
Mullet, salted					445,023	30,624
Mullet roe, fresh					13,945	1,653
Mullet roe, salted					20,765	1,836
Permit					8,493	266
Pigfish					6,156	179
Pinfish or sailor's choice					77,390	2,333
Pompano, fresh	1,220	218	2,530	287	292,079	53,572
Pompano, salted					1,000	100
Porgies					29,000	1,192
Porkfish					2,500	138
Sawfish					200,000	2,500
Sea bass	1,870	150			34,910	3,195
Sea gar, fresh			26,150	2,092	26,150	2,092
Sea gar, dried	1,150	92			1,150	92
Sergeantfish or snook					103,701	3,184
Sharks					3,000,000	24,000
Sheepshead	193,344	14,435	140,610	8,117	1,470,777	61,675
Snapper, mangrove					125,179	4,221
Snapper, mutton					28,225	1,013
Snapper, red	175,000	17,500	1,008,960	80,717	11,728,845	864,857
Spanish mackerel	2,600	361	78,920	8,200	3,864,815	318,475
Spot	23,435	829			122,369	3,904
Squeteagues or "sea trout"	783,214	73,031	1,523,965	154,238	4,356,906	426,668
Sturgeon					7,400	1,088
Sturgeon caviar					25	25
Tang					600	24
Yellowtail	2,500	72			41,172	2,494
Crabs, hard	312,600	7,626	108,900	8,665	[1] 940,144	30,472
Crabs, soft	3,000	1,050			[2] 11,800	3,230
Crabs, stone					7,200	1,200
Sea crawfish or spiny lobster					321,010	16,051
Shrimp, green	24,471,868	900,785	3,421,638	158,519	43,836,060	1,652,138
Shrimp, dried	410,117	83,284			410,117	83,284
Clams, hard					[3] 602,272	180,040
Conchs					2,500	50
Oysters, market, public	1,272,285	151,462	2,498,846	174,576	[4] 15,365,504	789,700
Oysters, market, private	5,882,478	618,972	21,000	1,500	[5] 9,457,805	784,745
Oysters, seed, public					[6] 630,000	13,500
Squid	5,800	580			5,800	580
Terrapin	22,250	7,512			31,782	12,030
Turtles	8,650	173	2,550	204	65,400	4,082
Sponge grass					97,277	18,059
Sponges, sheepswool					339,623	778,949
Sponges, wire					16,028	7,479
Sponges, yellow					121,665	69,085
Total	34,835,194	1,961,100	19,559,606	782,013	160,324,042	8,096,650

[1] 2,820,432 in number.
[2] 35,400 in number.
[3] 150,568 bushels.
[4] 2,195,072 bushels.
[5] 1,351,115 bushels.
[6] 90,000 bushels.

Wholesale fishery trade of the Gulf States, 1923

Item	Florida (west coast)		Alabama		Mississippi	
	Number	*Value*	*Number*	*Value*	*Number*	*Value*
Establishments	92	$1,030,860	9	$32,300	24	$80,440
Cash capital		222,950		11,750		17,250
Persons engaged	635		70		243	
Wages paid		511,846		30,207		63,989

Item	Louisiana		Texas		Total	
	Number	*Value*	*Number*	*Value*	*Number*	*Value*
Establishments	21	$196,645	33	$288,948	179	$1,629,193
Cash capital		34,250		59,830		346,030
Persons engaged	388		449		1,785	
Wages paid		177,898		116,289		900,229

Fish canning and by-products industries of the Gulf States, 1923

Item	Florida (west coast)		Alabama		Mississippi	
	Number	*Value*	*Number*	*Value*	*Number*	*Value*
Establishments	11	$580,963	10	$277,731	33	$1,023,395
Cash capital		54,000		54,000		116,050
Persons engaged	338		574		1,556	
Wages paid		170,930		153,881		539,525
Products		836,806		541,706		2,404,226

Item	Louisiana		Texas		Total	
	Number	*Value*	*Number*	*Value*	*Number*	*Value*
Establishments	36	$869,506	8	$223,296	98	$2,974,891
Cash capital		120,200		45,000		389,250
Persons engaged	2,159		249		4,876	
Wages paid		331,303		51,023		1,246,662
Products		2,309,617		172,558		6,264,913

Comparative statistics of extent of fisheries of the Gulf States, 1918 and 1923

States	Persons engaged				Capital invested			
	1918	1923	Increase		1918	1923	Increase	
	Number	*Number*	*Number*	*Per cent*				*Per cent*
Florida	5,161	5,827	666	12.9	$2,404,245	$4,160,511	$1,756,266	73.0
Alabama	783	1,212	429	54.8	334,741	671,201	336,460	100.5
Mississippi	2,867	3,499	632	22.0	1,433,585	1,913,708	480,123	33.5
Louisiana	4,191	5,158	967	23.1	1,475,188	2,606,297	1,131,109	76.7
Texas	1,886	2,097	211	11.2	890,100	1,184,188	294,088	33.0
Total	14,888	17,793	2,905	19.5	6,537,859	10,535,905	3,998,046	61.2

States	Products							
	Pounds				Value			
	1918	1923	Increase or decrease		1918	1923	Increase	
				Per cent				*Per cent*
Florida	54,753,639	73,266,267	+18,512,628	+33.8	$3,420,363	$4,026,227	$605,864	17.7
Alabama	5,609,219	7,631,237	+2,022,018	+36.0	230,567	341,569	111,002	48.1
Mississippi	20,592,089	25,031,738	+4,439,649	+21.6	762,770	985,741	222,971	29.2
Louisiana	24,953,876	34,835,194	+9,881,318	+39.6	1,419,367	1,961,100	541,733	38.2
Texas	25,014,760	19,559,606	−5,455,154	−21.8	677,243	782,013	104,770	15.5
Total	130,923,583	160,324,042	+29,400,459	+22.5	6,510,310	8,096,650	1,586,340	24.4

Comparative statistics of the products of the fisheries of the Gulf States for various years, 1880 to 1923

Year	Florida (west coast)		Alabama		Mississippi	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
1880	8,376,335	$564,819	3,541,500	$119,275	788,500	$22,540
1887					6,548,175	189,716
1888	19,597,084	802,282	1,633,589	75,560	7,883,010	231,712
1889	23,597,240	948,845	4,560,269	146,841	8,933,339	250,884
1890	27,418,562	1,064,139	4,776,968	154,871	8,131,401	245,699
1897	28,255,219	944,793	4,699,381	134,438	7,829,685	192,298
1902	48,120,019	1,462,166	9,351,447	266,682	23,426,965	553,220
1908	37,566,000	2,120,000	10,665,000	387,000	17,302,000	459,000
1918	54,753,639	3,420,363	5,609,219	230,567	20,592,089	762,770
1923	73,266,267	4,026,227	7,631,237	341,569	25,031,738	985,741

Year	Louisiana		Texas		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
1880	6,996,000	$392,610	3,858,875	$128,300	23,561,210	$1,227,544
1887	18,455,489	579,504	6,282,489	256,250		
1888	19,121,056	612,820	6,609,161	271,257	54,843,900	1,993,631
1089	20,947,239	621,048	7,357,800	297,258	65,395,887	2,264,876
1890	20,789,203	660,134	7,959,400	313,832	69,075,534	2,438,675
1897	17,401,788	713,587	7,174,550	286,610	65,360,623	2,271,726
1902	24,754,135	858,314	8,044,404	353,814	113,696,970	3,494,196
1908	42,302,000	1,448,000	10,439,000	446,000	118,274,000	4,860,000
1918	24,953,876	1,419,367	25,014,760	677,243	130,923,583	6,510,310
1923	34,835,194	1,961,100	19,559,606	782,013	160,324,042	8,096,650

NOTE.—The statistics for 1908 in this table are from data published by the Bureau of the Census.

Comparative statistics of the oyster industry of the Gulf States for various years, 1880 to 1923 [1]

Year	Florida (west coast)		Alabama		Mississippi	
	Bushels	*Value*	*Bushels*	*Value*	*Bushels*	*Value*
1880	58,600	$10,950	104,500	$44,950	25,000	$10,000
1887	[2]	[2]	[2]	[2]	581,100	118,974
1888	181,445	44,448	76,125	32,174	767,205	157,463
1889	294,871	75,189	438,425	96,758	845,503	167,713
1890	371,081	93,692	481,070	107,812	806,478	166,672
1895	170,518	46,308	[2]	[2]	[2]	[2]
1897	179,715	50,258	255,053	60,207	629,713	110,964
1902	579,587	124,108	347,460	119,773	2,405,132	426,222
1908	538,000	187,000	590,400	172,940	1,067,600	295,340
1911	187,462	109,472	441,917	72,742	657,670	140,420
1918	373,706	121,820	147,413	39,670	1,272,389	307,326
1923	234,592	68,564	323,086	100,219	1,696,422	472,652

Year	Louisiana		Texas		Total	
	Bushels	*Value*	*Bushels*	*Value*	*Bushels*	*Value*
1880	295,000	$200,000	67,054	$47,300	550,154	$313,200
1887	678,227	215,163	256,199	88,275	[2]	[2]
1888	719,992	230,820	341,275	109,633	2,086,042	574,538
1889	835,520	269,057	360,600	111,400	2,774,919	720,117
1890	841,585	299,896	440,800	127,990	2,941,014	796,062
1895	[2]	[2]	[2]	[2]	[2]	[2]
1897	959,190	432,668	355,910	94,663	2,379,581	748,760
1902	1,198,413	493,227	343,113	100,359	4,873,705	1,263,689
1908	3,623,800	762,800	497,200	167,880	6,317,000	1,585,960
1911	4,504,402	1,022,723	434,690	131,609	6,226,141	1,476,966
1918	1,122,203	494,299	477,784	143,610	3,393,495	1,106,725
1923	1,022,109	770,434	359,978	176,076	3,636,187	1,587,945

[1] The statistics for 1908 in this table are from data published by the Bureau of the Census.
[2] Statistics not available.

COMPARATIVE YIELD OF VARIOUS SPECIES IN 1923 AND PREVIOUS YEARS

In the foregoing statistics of the products of the fisheries, a number of species have been shown fresh and salted as marketed by the fishermen, the quantity salted varying more or less in various years. In order to afford a comparison of the total catch of the more important species on a uniform basis, the quantities salted by the fishermen have been converted to the equivalent of weights of fresh fish,

and the total catch of each species is shown as in the fresh condition in the tables below. Varying practices in salting fish make it difficult to determine the actual shrinkage that occurs when fresh fish are salted. The losses in salting the various species are thought to be approximately as follows: Menhaden and mullet, 33½ per cent; bluefish, crevallés, Spanish mackerel, pompano, and squeteague, 50 cent; red and black drum, 65 per cent, and these figures were used as the basis for converting the salt fish to a fresh-fish basis throughout the comparisons. Dried shrimp weigh one-eighth as much as fresh shrimp. The statistics on oysters, clams, and scallops are given in pounds and represent the meats or edible portion only.

Certain species of importance that occur in all of the Gulf States have been assembled in the first of the following tables. Of the nine varieties of fishes given in this table, the yield of seven shows a general upward trend. Only one of these (the red drum) has increased in yield with each successive canvass. Two of them (black drum and groupers) increased remarkably from 1890 to 1918, but the 1923 statistics record a distinct decline. The other four (mullet, red snapper, squeteague, and Spanish mackerel) have not registered continued increases since 1902, although the yield has not declined greatly. In fact, the mullet production in 1918 and 1923 was slightly greater than the record catch of 1902, and the Spanish mackerel was considerably more productive in 1923 than in any previous year recorded. Of the two remaining species sheepshead seem to have suffered an irregular decline and croakers registered the lowest yield in 1923 of any previously recorded.

Of the three varieties of shellfish, shrimp only have increased remarkably in recent years. The oyster production in 1918 and 1923 was only about half as large as in 1908, and the crab yield in 1918 and 1923 was only slightly more than half as large as in 1897 and 1902.

Comparison of the recorded yield of certain species taken in the fisheries of the Gulf States, in pounds, 1890 to 1923

ALL STATES

Year	Croaker	Drum		Groupers	Mullet	Sheepshead
		Black	Red, or redfish			
1890	532, 540	136, 053	2, 160, 767	427, 781	16, 820, 119	1, 921, 728
1897	[1]	117, 825	2, 257, 944	853, 618	16, 643, 274	1, 565, 811
1902	543, 810	418, 875	2, 607, 881	1, 112, 258	28, 598, 360	1, 974, 815
1908	778, 000		[2] 3, 028, 000	1, 625, 000	18, 988, 000	1, 125, 000
1918	714, 692	2, 011, 288	2, 999, 776	5, 935, 825	30, 026, 213	1, 558, 514
1923	368, 610	1, 231, 972	3, 132, 643	4, 639, 031	31, 030, 718	1, 470, 777

Year	Snapper, red	Spanish mackerel	Squeteagues, or "sea trout"	Crabs	Shrimps	Oysters
1890	4, 480, 617	707, 259	3, 010, 783	1, 218, 660	7, 451, 350	20, 587, 098
1897	6, 114, 278	750, 255	3, 157, 208	1, 780, 433	6, 791, 021	16, 657, 138
1902	13, 608, 553	1, 624, 441	4, 843, 145	1, 708, 625	12, 366, 915	34, 115, 935
1908	12, 546, 000	1, 486, 000	4, 090, 000	1, 259, 000	12, 865, 000	44, 403, 000
1918	9, 429, 802	3, 522, 045	4, 992, 363	821, 244	32, 347, 821	23, 754, 465
1923	11, 728, 845	3, 864, 815	4, 356, 903	959, 144	47, 116, 996	25, 453, 309

[1] Figures not available.
[2] Probably includes some black drum, for which no separate figures are available.

Comparison of the recorded yield of certain species taken in the fisheries of the Gulf States, in pounds, 1890 to 1923—Continued

WEST COAST OF FLORIDA

Year	Bluefish	Cero and kingfish	Crevalle [1]	Drum		Groupers
				Black	Red, or redfish	
1890	420,046	291,725	332,864	121,853	457,737	398,731
1897	264,971	440,000	45,640	37,855	236,368	781,155
1902	352,606	151,900	84,690	193,625	1,104,251	437,089
1908	580,000	37,000	227,000	----------	[2] 608,000	1,231,000
1918	270,648	465,860	561,435	57,420	958,407	5,626,329
1923	417,840	564,128	508,052	95,294	1,398,291	4,265,569

Year	Menhaden	Mullett	Pompano	Sheepshead	Snapper, red	Spanish mackerel
1890	----------	15,555,964	341,656	543,797	4,172,942	447,793
1897	----------	15,575,455	405,601	663,347	5,314,487	503,480
1902	2,500	26,309,800	487,099	1,373,650	8,074,066	1,513,456
1908	----------	16,144,600	232,000	473,000	7,659,000	1,419,000
1918	295,063	26,380,059	242,142	988,662	7,230,168	3,463,101
1923	10,955,825	28,454,464	282,403	1,025,415	9,471,267	3,772,028

Year	Squeteagues, or "sea trout"	Sturgeon	Crabs	Sea crawfish, or spiny lobster	Shrimp	Oysters
1890	653,813	----------	----------	----------	----------	2,597,567
1897	830,040	9,254	6,240	157,500	----------	1,258,008
1902	1,912,810	348,982	13,294	55,664	17,280	4,057,107
1908	1,207,000	6,700	64,400	53,000	8,000	3,764,000
1918	1,693,936	4,927	24,500	322,015	3,250,468	2,615,942
1923	1,590,523	7,425	7,200	321,010	2,881,454	1,642,144

[1] Includes blue runner or hardtail.
[2] Probably includes some black drum, for which no separate figures are available.

ALABAMA

Year	Croaker	Drum		Groupers	Mullet	Sheepshead
		Black	Red, or redfish			
1890	98,075	7,000	54,464	11,250	587,555	35,114
1897	[1]	6,000	213,000	69,000	600,300	86,800
1902	57,900	4,910	70,315	635,000	1,546,300	75,050
1908	72,000	----------	[2] 151,000	394,000	1,656,000	24,000
1918	93,500	12,200	23,250	244,000	1,702,530	28,050
1923	36,600	9,250	14,765	304,600	648,200	20,640

Year	Snapper, red	Spanish mackerel	Squeteagues or "sea trout"	Crabs	Shrimp	Oysters
1890	62,375	43,966	208,750	----------	----------	3,367,490
1897	335,000	85,500	296,100	24,400	40,600	1,785,438
1902	3,466,500	33,650	259,450	75,230	200	2,432,222
1908	2,635,000	13,000	208,000	246,000	37,000	4,132,000
1918	798,400	4,284	138,630	95,850	1,265,612	1,031,891
1923	970,000	1,185	48,910	84,000	3,182,000	2,261,602

[1] Figures not available.
[2] Probably includes some black drum, for which no separate figures are available.

Comparison of the recorded yield of certain species taken in the fisheries of the Gulf States, in pounds, 1890 to 1923—Continued

MISSISSIPPI

Year	Croaker	Drum		Groupers	Mullet	Sheepshead
		Black	Red, or redfish			
1890	57,325	3,200	201,300	----------	305,400	173,200
1897	[1]	5,000	199,000	----------	240,600	110,150
1902	273,000	11,660	93,270	----------	602,750	70,225
1908	176,000	----------	[2] 244,000	----------	1,035,000	81,000
1918	40,600	13,777	115,685	24,656	1,565,172	67,612
1923	45,015	38,989	176,760	26,137	1,739,026	90,768

Year	Snapper, red	Spanish mackerel	Squeteagues or "sea trout"	Crabs	Shrimp	Oysters
1890	----------	46,500	372,100	47,160	613,500	5,645,346
1897	----------	64,760	452,800	152,840	1,903,165	4,407,992
1902	----------	7,455	473,345	265,166	4,423,900	16,835,924
1908	----------	7,100	517,000	427,000	4,121,000	7,473,000
1918	98,232	11,531	356,070	225,025	9,147,445	8,906,723
1923	103,618	10,082	410,294	443,444	9,879,100	11,874,954

[1] Figures not available.
[2] Probably includes some black drum, for which no separate figures are available.

LOUISIANA

Year	Croaker	Drum		Groupers	Mullet	Sheepshead
		Black	Red or redfish			
1890	158,267	----------	339,316	17,800	287,750	390,817
1897	[1]	18,570	465,200	----------	165,819	238,010
1902	154,860	51,280	441,595	----------	122,710	338,560
1908	369,000	----------	[2] 716,000	----------	133,000	249,000
1918	383,035	54,455	565,899	20,000	325,177	276,528
1923	219,025	59,988	665,067	10,000	181,485	193,344

Year	Snapper, red	Spanish mackerel	Squeteagues, or "sea trout"	Crabs	Shrimp	Oysters
1890	240,500	144,000	655,670	980,700	6,662,050	5,891,095
1897	----------	55,805	566,648	1,458,833	4,486,726	6,714,330
1902	----------	6,050	1,078,240	1,312,135	7,634,720	8,388,891
1908	----------	4,900	1,103,000	322,000	8,581,000	25,554,000
1918	60,000	1,775	1,190,357	281,925	18,520,229	7,855,421
1923	175,000	2,600	783,214	315,600	27,752,804	7,154,763

[1] Figures not available.
[2] Probably includes some black drum, for which no separate figures are available.

Comparison of the recorded yield of certain species taken in the fisheries of the Gulf States, in pounds, 1890 to 1923—Continued

TEXAS

Year	Croaker	Drum		Groupers	Menhaden	Sheepshead
		Black	Red, or redfish			
1890	175,950	4,000	1,107,950			778,800
1897	(1)	50,400	1,144,376	3,463		467,504
1902	58,050	157,400	898,450	40,169		217,330
1908	159,000		[2] 1,309,000			298,000
1918	197,557	1,873,436	1,336,535	20,840	14,118,340	197,662
1923	67,970	1,028,451	877,760	32,725	8,517,000	140,610

Year	Snapper, red	Spanish mackerel	Squeteagues or "sea trout"	Crabs	Shrimp	Oysters
1890	4,800	25,000	1,120,450	190,800	175,800	3,085,600
1897	464,791	40,710	1,011,620	138,120	360,530	2,491,370
1902	2,067,987	63,830	1,119,300	42,800	290,815	2,401,791
1908	2,252,000	42,000	1,055,000	199,600	118,000	3,480,000
1918	1,243,002	41,354	1,613,370	193,944	164,067	3,344,488
1923	1,008,960	78,920	1,523,965	108,900	3,421,638	2,519,846

[1] Figures not available.
[2] Probably includes some black drum, for which no separate figures are available.

WEST COAST OF FLORIDA

The statistics of the fisheries here given include only the west or Gulf coast of Florida.[5] The fisheries of this part of Florida were greater than those of any other of the Gulf States, employing 4,854 persons, of whom 782 were on fishing vessels, 97 on transporting vessels, 3,758 in the shore and boat fisheries, and 217 were shoresmen. The investment amounted to $2,271,738. This included 98 fishing vessels, valued at $723,876, with a net tonnage of 2,640 tons and outfits valued at $207,840; 38 transporting vessels, valued at $114,355, with a net tonnage of 571 tons and outfits valued at $22,550; 1,289 power boats, valued at $642,038; 1,745 sail and row boats, valued at $79,045; fishing apparatus employed on vessels to the value of $14,159; apparatus employed in the shore and boat fisheries to the value of $308,449; and shore property to the value of $159,426.

The products of the fisheries amounted to 73,266,267 pounds, valued at $4,026,227. This represents an increase of 33.8 per cent in quantity and 17.7 per cent in value, as compared with the statistics for 1918. The leading products were mullet, 28,221,570 pounds, valued at $1,125,496; sponges, 574,593 pounds, valued at $873,572; red snapper, 9,471,267 pounds, valued at $680,232; Spanish mackerel, 3,772,028 pounds, valued at $308,829; hard clams 602,272 pounds, valued at $180,040; squeteagues or "sea trout," 1,590,523 pounds, valued at $157,169; shrimps, 2,881,454 pounds, valued at $114,509;

[5] Statistics for the east coast of Florida for 1923 are given in Fishery Industries of the United States, 1924, by Oscar E. Sette. Appendix VII, Report of the Commissioner of Fisheries, 1925, Bureau of Fisheries Document No. 997, pp. 219–408.

and groupers, 4,265,569 pounds, valued at $110,689. The other 44 varieties of fisheries products, each valued at less than $100,000, aggregated 21,886,991 pounds, valued at $475,691.

Fisheries.—The vessel fisheries of the west coast of Florida employed purse seines, gill nets, lines, otter trawls, dip nets, tongs, and sponge apparatus, the total yield of which amounted to 21,801,071 pounds, valued at $848,640. Judging from the value of the products, the yield by lines was most important, amounting to 10,906,343 pounds, valued at $655,269, of which red snapper, with 7,964,907 pounds, valued at $580,020, was the species of greatest value, followed by groupers with a yield of 2,721,396 pounds, valued at $64,488; six less important varieties made up the remainder of the catch by lines. The yield of the sponge apparatus was next in importance, amounting to 73,892 pounds of sponges, valued at $109,182. Purse seines, which caught 10,563,225 pounds of menhaden, valued at $70,421, also may be mentioned among the apparatus with important yields. The other forms of apparatus each produced about $5,000 worth of products.

The shore and boat fisheries produced 51,465,196 pounds, valued at $3,177,587. Gill nets produced the largest catch—27,282,918 pounds, valued at $1,232,437. Of this amount 19,028,591 pounds, valued at $762,692, were mullet; 2,812,948 pounds, valued at $271,148 were Spanish mackerel; and 26 less important varieties made up the remainder. Sponge apparatus was next in importance, yielding 500,701 pounds, valued at $764,390, most of which were sheepswool sponges. Haul seines ranked third, with a yield of 9,136,614 pounds, valued at $372,580, consisting chiefly of mullet. Lines produced 3,956,292 pounds, valued at $205,787, of which 1,502,713 pounds, valued at $100,030, were red snappers; 1,529,688 pounds, valued at $45,768, groupers; 470,264 pounds, valued at $30,670, cero and kingfish; and the remainder was made up of many species in smaller quantities. Dredges produced 597,472 pounds of hard clams, valued at $179,240; stop nets produced 3,528,104 pounds, valued at $126,985, composed largely of mullet; otter trawls produced 2,814,237 pounds of shrimp, valued at $111,935; and other gear, such as trammel nets, pound nets, fyke nets, spears, dip nets, crawfish traps, and tongs, made up the remainder of the catch of the shore and boat fisheries.

Wholesale trade and industries.—The wholesale fish trade was comprised of 92 firms that employed 635 persons, paid $511,846 in wages, and had property and cash capital to the value of $1,253,810.

In the fish canning and by-products industries there were 11 establishments, valued at $580,963, which had cash capital to the amount of $54,000 and employed 338 persons, to whom $170,930 were paid in wages. The total output was valued at $836,806, of which canned shrimp and oysters accounted for $360,303; other canned fishery products, $286,859; and miscellaneous products and by-products, $189,644.

The following tables and summary statements present the detailed statistics of the fisheries of the west coast of Florida in 1924.[6]

[6] For statistics on persons engaged, vessels, boats, gear, and investment in the fisheries refer to page 266.

Yield of the vessel fisheries of the west coast of Florida, by species and apparatus

Item	Pounds	Value
By purse seines: Menhaden	10,563,225	$70,421
By gill nets:		
Drum, red, or redfish	50	2
Flounders	300	15
Mullet, fresh	35,000	1,400
Mullet, salted	5,000	300
Mullet roe, salted	500	40
Pompano	500	100
Squeteagues or "sea trout"	6,500	650
Sturgeon	150	8
Turtles	41,500	2,490
Total	89,500	5,005
By lines:		
Amberfish	9,175	184
Cero and kingfish	93,864	7,416
Groupers	2,721,396	64,488
Jewfish	91,751	2,053
Porgies	6,100	242
By lines—Continued		
Snapper, mutton	16,650	$666
Snapper, red	7,964,907	580,020
Yellowtail	2,500	200
Total	10,906,343	655,269
By otter trawls: Shrimp	67,217	2,574
By dip nets: Sea crawfish or spiny lobster	25,000	1,250
By tongs: Oysters, market, public	75,894	4,939
By sponge apparatus:		
Sponges—		
Grass	8,504	2,080
Sheepswool	31,601	84,885
Yellow	33,787	22,217
Total	73,892	109,182
Grand total	21,801,071	848,640

Yield of the shore fisheries of the west coast of Florida in 1923, by apparatus and species

Species	Haul seines		Trammel nets		Gill nets		Pound nets	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Angelfish	8,400	$256	1,725	$56	7,815	$247	900	$27
Bluefish	176,867	8,639	1,875	282	103,405	9,910	132,450	19,868
Blue runner or hardtail	232,665	6,745			26,185	869	80,618	8,062
Bonito	25,980	939			1,800	54		
Catfish	29,980	880			4,800	144		
Crevallé	52,103	1,498	2,820	84	63,056	1,894	6,400	192
Drum, black	33,982	1,049	30,540	904	13,615	411		
Drum, red or redfish	269,070	8,178	561,892	16,942	349,512	11,360	20,450	614
Elops or ten-pounder	345,235	10,373			7,851	235		
Flounders	19,538	782	11,770	1,018	13,927	841		
Groupers	4,825	145						
Grunts	5,750	174						
Harvestfish or "butterfish"					1,000	45		
Hogfish	4,948	149						
Jewfish	25	1						
King whiting	26,563	1,117	1,273	102	5,680	216	40,500	4,050
Menhaden	359,600	7,222			33,000	660		
Mullet, fresh	5,535,227	222,405	385,192	14,483	18,768,591	741,844		
Mullet, salted	190,968	10,949	3,000	180	246,055	19,195		
Mullet roe, fresh					13,945	1,653		
Mullet roe, salted	20,265	1,796						
Permit	5,153	160			2,790	87		
Pigfish	4,481	127						
Pinfish or sailor's choice	35,325	1,060	975	30	29,750	901		
Pompano, fresh	89,490	13,304	4,661	955	179,317	35,848	5,000	1,000
Pompano, salted	1,000	100						
Sawfish					200,000	2,500		
Sea bass							500	50
Sergeantfish or snook	97,530	2,963						
Sharks					3,000,000	24,000		
Sheepshead	352,094	10,794	17,298	785	395,467	12,514	6,000	180
Snapper, mangrove	34,680	1,042	4,500	157	59,424	2,226		
Spanish mackerel	814,993	27,343	1,862	186	2,812,948	271,148	135,685	9,498
Spot	24,772	813	9,700	203	7,417	234	13,500	405
Squeteagues or "sea trout"	315,828	30,966	108,312	10,175	919,793	91,361	75,700	7,570
Sturgeon					7,250	1,080		
Sturgeon caviar					25	25		
Yellowtail	16,577	476			500	15		
Turtles	2,700	135			8,000	920		
Total	9,136,614	372,580	1,147,395	46,542	27,282,918	1,232,437	517,703	51,516

Yield of the shore fisheries of the west coast of Florida in 1923, by apparatus and species—Continued

Species	Fyke nets		Stop nets		Spears		Lines	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Amberfish							4,670	$138
Angelfish			9,224	$311			600	18
Barracuda							1,600	64
Bluefish							3,243	326
Blue runner or hardtail							12,500	500
Bonito							250	17
Catfish	80,000	$4,289						
Cero and kingfish							470,264	30,670
Crevallé			30,930	927			775	23
Drum, black			17,157	514				
Drum, red, or redfish			165,742	5,090			31,575	1,063
Elops or ten-pounder			650	20				
Flounders			780	30	25,000	$1,250		
Groupers			9,660	289			1,529,688	45,767
Grunts			3,290	100			85,827	2,572
Hogfish			1,500	45			3,000	90
Jewfish							17,412	511
King whiting			3,005	89				
Leatherjacket or "turbot"							1,450	53
Moonfish							775	22
Mullet			3,017,827	111,251				
Permit			250	10			300	9
Pigfish			1,675	52				
Pinfish or sailor's choice			8,340	252			3,000	90
Pompano			1,035	159			400	80
Porgies							22,500	938
Porkfish							2,500	138
Sea bass							24,600	2,400
Sergeantfish or snook			3,621	144			2,550	77
Sheepshead			241,431	7,265			13,125	425
Snapper, mangrove			7,450	222			19,125	574
Snapper, mutton							11,575	347
Snapper, red			3,647	182			1,502,713	100,030
Spanish mackerel							6,540	654
Spot			540	22				
Squeteagues or "sea trout"							164,390	16,447
Tang							600	24
Yellowtail			350	11			18,745	1,720
Total	80,000	4,289	3,528,104	126,985	25,000	1,250	3,956,292	205,787

Species	Otter trawls		Sponge apparatus		By hand	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Crabs, stone					7,200	$1,200
Conchs					2,500	50
Shrimp	2,814,237	$111,935				
Sponges:						
Grass			88,773	$15,979		
Sheepswool			308,022	694,064		
Wire			16,028	7,479		
Yellow			87,878	46,868		
Turtles					2,000	160
Total	2,814,237	111,935	500,701	764,390	11,700	1,410

Species	Tongs		Dredges		Dip nets		Crawfish traps	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Clams, hard	4,800	$800	597,472	$179,240				
Oysters, market, public	1,566,250	63,625						
Sea crawfish or spiny lobster					274,560	$13,728	21,450	$1,073
Total	1,571,050	64,425	597,472	179,240	274,560	13,728	21,450	1,073

Summary of the yield

Species	Vessel fishery		Shore fishery		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Amberfish	9,175	$184	4,670	$138	13,845	$322
Angelfish			28,664	915	28,664	915
Barracuda			1,600	64	1,600	64
Bluefish			417,840	39,025	417,840	39,025
Blue runner or hardtail			351,968	16,176	351,968	16,176
Bonito			28,030	1,010	28,030	1,010
Catfish			114,780	5,313	114,780	5,313
Cero and kingfish	93,864	7,416	470,264	30,670	564,128	38,086
Crevallé			156,084	4,618	156,084	4,618
Drum, black			95,294	2,878	95,294	2,878
Drum, red or redfish	50	2	1,398,241	43,247	1,398,291	43,249
Elops or ten-pounder			353,736	10,628	353,736	10,628
Flounders	300	15	71,015	3,921	71,315	3,936
Groupers	2,721,396	64,488	1,544,173	46,201	4,265,569	110,689
Grunts			94,867	2,846	94,867	2,846
Harvest fish or "butterfish"			1,000	45	1,000	45
Hogfish			9,448	284	9,448	284
Jewfish	91,751	2,053	17,437	512	109,188	2,565
King whiting			77,021	5,574	77,021	5,574
Leather jacket or "turbot"			1,450	53	1,450	53
Menhaden	10,563,225	70,421	392,600	7,882	10,955,825	78,303
Moonfish			775	22	775	22
Mullet, fresh	35,000	1,400	27,706,837	1,089,983	27,741,837	1,091,383
Mullet, salted	5,000	300	440,023	30,324	445,023	30,624
Mullet roe, fresh			13,945	1,653	13,945	1,653
Mullet roe, salted	500	40	20,265	1,796	20,765	1,836
Permit			8,493	266	8,493	266
Pigfish			6,156	179	6,156	179
Pinfish or sailor's choice			77,390	2,333	77,390	2,333
Pompano, fresh	500	100	279,903	51,346	280,403	51,446
Pompano, salted			1,000	100	1,000	100
Porgies	6,100	242	22,500	938	28,600	1,180
Porkfish			2,500	138	2,500	138
Sawfish			200,000	2,500	200,000	2,500
Sea bass			25,100	2,450	25,100	2,450
Sergeantfish or snook			103,701	3,184	103,701	3,184
Sharks			3,000,000	24,000	3,000,000	24,000
Sheepshead			1,025,415	31,963	1,025,415	31,963
Snapper, mangrove			125,179	4,221	125,179	4,221
Snapper, mutton	16,650	666	11,575	347	28,225	1,013
Snapper, red	7,964,907	580,020	1,506,360	100,212	9,471,267	680,232
Spanish mackerel			3,772,028	308,829	3,772,028	308,829
Spot			55,929	1,677	55,929	1,677
Squeteagues or "sea trout"	6,500	650	1,584,023	156,519	1,590,523	157,169
Sturgeon	150	8	7,250	1,080	7,400	1,088
Sturgeon caviar			25	25	25	25
Tang			600	24	600	24
Yellowtail	2,500	200	36,172	2,222	38,672	2,422
Crabs, stone			7,200	1,200	7,200	1,200
Sea crawfish or spiny lobster	25,000	1,250	296,010	14,801	321,010	16,051
Shrimp	67,217	2,574	2,814,237	111,935	2,881,454	114,509
Clams			602,272	180,040	602,272	180,040
Conchs			2,500	50	2,500	50
Oysters, market, public	75,894	4,939	1,566,250	63,625	1,642,144	68,564
Turtles	41,500	2,490	12,700	1,215	54,200	3,705
Sponges, grass	8,504	2,080	88,773	15,979	97,277	18,059
Sponges, sheepswool	31,601	84,885	308,022	694,064	339,623	778,949
Sponges, wire			16,028	7,479	16,028	7,479
Sponges, yellow	33,787	22,217	87,878	46,868	121,665	69,085
Total	21,801,071	848,640	51,465,196	3,177,587	73,266,267	4,026,227

Summary by counties

County	Persons engaged	Investment	Products	
	Number	*Dollars*	*Pounds*	*Value*
Bay	293	218,488	3,561,905	$196,132
Calhoun	157	94,720	11,049,782	99,266
Charlotte	363	132,809	8,345,031	391,202
Citrus	172	23,861	1,874,158	84,385
Collier	181	113,705	3,382,227	296,331
Dixie	24	4,869	644,755	26,019
Escambia	503	603,683	8,260,835	485,562
Franklin	463	214,001	6,275,871	264,148
Hernando	11	1,430	264,650	10,941
Hillsborough	140	50,600	1,525,415	67,796
Jefferson	20	3,545	248,250	13,175
Lee	286	87,072	3,612,892	152,592
Levy	209	95,016	3,653,939	168,303
Manatee	194	56,164	2,615,873	123,626
Monroe	507	176,389	6,461,501	399,858
Okaloosa	106	36,856	1,745,449	72,571
Pasco	46	7,045	1,120,275	45,993
Pinellas	855	285,266	5,041,948	963,639
Santa Rosa	20	3,965	194,449	11,389
Sarasota	83	30,324	958,430	44,338
Taylor	35	5,605	780,625	37,790
Wakulla	186	26,325	1,648,007	71,171
Total	4,854	2,271,738	73,266,267	4,026,227

Yield and average prices of sponges of the west coast of Florida, 1880 to 1923

Year	Sheepswool			Yellow		
	Pounds	Value	Average price per pound	Pounds	Value	Average price per pound
1880	(1)	(1)	(1)	(1)	(1)	(1)
1889	(1)	(1)	(1)	(1)	(1)	(1)
1890	(1)	(1)	(1)	(1)	(1)	(1)
1895	231,272	$363,107	$1.57	29,509	$11,789	$0.39
1896	149,724	248,196	1.66	23,655	9,318	.40
1897	157,476	240,599	1.53	32,362	13,082	.40
1899	153,700	332,390	2.16	55,800	16,205	.29
1900	181,311	483,263	2.67	74,466	44,045	.59
1901	202,673	422,561	2.08	62,512	39,290	.63
1902	133,518	297,727	2.23	56,787	31,113	.55
1908 [2]	(1)	(1)	(1)	(1)	(1)	(1)
1918	276,168	675,781	2.44	91,641	34,187	.37
1923	339,623	778,949	2.29	121,665	69,085	.57

Year	Grass			Other			Total		
	Pounds	Value	Average price per pound	Pounds	Value	Average price per pound	Pounds	Value	Average price per pound
1880	(1)	(1)	(1)	(1)	(1)	(1)	207,000	$200,750	$1.07
1889	(1)	(1)	(1)	(1)	(1)	(1)	316,559	381,087	1.20
1890	(1)	(1)	(1)	(1)	(1)	(1)	366,772	438,682	1.19
1895	21,387	$5,464	$0.26	23,952	$6,502	$0.27	306,120	386,871	1.26
1896	44,617	11,508	.26	18,315	3,990	.22	236,311	273,012	1.16
1897	128,622	29,188	.23	13,086	3,171	.24	331,546	286,040	.86
1899	76,900	14,319	.19	18,000	5,000	.28	304,400	367,914	1.21
1900	143,112	33,263	.23	19,236	7,114	.37	418,125	567,685	1.36
1901	108,748	24,210	.22	21,627	6,679	.31	395,560	492,740	1.25
1902	140,682	29,765	.21	15,902	5,817	.37	346,889	364,422	1.05
1908 [2]	(1)	(1)	(1)	(1)	(1)	(1)	622,000	545,000	.87
1918	73,033	12,125	.16	11,346	3,062	.27	452,188	725,155	1.60
1923	97,277	18,059	.19	16,028	7,479	.47	574,593	873,572	1.52

[1] Statistics not available.

[2] From data published by the Bureau of the Census.

ALABAMA

The fisheries of Alabama in 1923 employed 568 persons, of whom 88 were on fishing vessels, 34 on transporting vessels, and 446 in the shore and boat fisheries. The investment, amounting to $295,420, included 17 fishing vessels with a total net tonnage of 250 tons, valued at $57,485 and with outfits to the value of $16,425; 14 transporting vessels with a total net tonnage of 147 tons, valued at $26,130 and with outfits to the value of $1,620; 196 power boats, valued at $165,150; 225 rowboats, valued at $4,405; fishing apparatus on vessels to the value of $1,430; fishing apparatus in the shore and boat fisheries to the value of $15,150; and shore and accessory property valued at $7,625. The products of the fisheries amounted to 7,631,237 pounds, valued at $341,569. Shrimp was the most important product, yielding 3,182,000 pounds, valued at $119,239; oysters were next with 2,261,602 pounds, valued at $100,219; red snappers followed with 970,000 pounds, valued at $77,600; mullet with 648,200 pounds, valued at $22,473; and 18 varieties, aggregating 569,441 pounds, valued at $22,038, made up the remainder of the catch.

Fisheries.—The vessel fisheries of Alabama employed trammel nets, lines, and otter trawls and produced 1,560,860 pounds of fishery products, valued at $96,065. The yield by lines was most important, amounting to 1,274,600 pounds, valued at $85,215, of which 970,000 pounds, valued at $77,600, were red snappers and 304,600 pounds, valued at $7,615, were groupers. Otter trawls were next, with a yield of 245,500 pounds of shrimp, valued at $9,227. Trammel nets produced 8 varieties of fish that aggregated 40,760 pounds, valued at $1,623, of which mullet was most important.

The shore and boat fisheries employed haul seines, trammel nets, lines, otter trawls, and tongs that produced 6,070,377 pounds, valued at $245,504. The catch by otter trawls, consisting of 2,711,500 pounds of shrimp, valued at $101,674, was most important. Tongs were next, producing 2,261,602 pounds of oysters, valued at $100,219. The yield by trammel nets was 718,350 pounds, valued at $27,414, consisting mostly of mullet; by haul seines, 269,125 pounds, valued at $10,957, consisting mostly of shrimp; and by lines 109,800 pounds, valued at $5,240, mostly hard crabs and squeteagues or "sea trout."

Wholesale trade and industries.—The wholesale fishery trade was conducted in 9 establishments, valued at $32,300, with cash capital of $11,750, that employed 70 persons to whom $30,207 was paid in wages.

The fish canning and by-products industries were conducted by 10 establishments, valued at $277,731, with cash capital amounting to $54,000 and employing 574 persons, to whom $153,881 was paid in wages. The total output was valued at $541,706 and consisted of 61,630 cases of canned shrimp, valued at $384,618; 11,522 cases of canned oysters valued at $57,396; and 11,208 tons of by-products, valued at $99,692.

The following tables and summary statements present the detailed statistics of the fisheries of Alabama in 1924.[7]

[7] For statistics on persons engaged, vessels, boats, gear, and investment in the fisheries refer to page 266.

Yield of the vessel fisheries of Alabama in 1923, by apparatus and species

Apparatus and species	Total		Apparatus and species	Total	
Trammel nets:	*Pounds*	*Value*	Lines:	*Pounds*	*Value*
Angelfish	200	$20	Groupers	304,600	$7,615
Croaker	1,650	66	Snapper, red	970,000	77,600
Drum, red or redfish	2,300	184			
King whiting	180	13	Total	1,274,600	85,215
Mullet	32,500	975			
Pompano	50	13	Otter trawls: Shrimp	245,500	9,227
Sheepshead	1,200	84			
Squeteagues or "sea trout"	2,680	268	Grand total	1,560,860	96,065
Total	40,760	1,623			

Yield of the shore fisheries of Alabama in 1923, by apparatus and species

Species	Haul seines		Trammel nets		Lines	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Angelfish	400	$12	1,340	$40		
Bluefish	3,500	210				
Blue runner or hardtail	1,200	36				
Catfish	1,500	60	12,920	488	1,800	$90
Croaker	4,000	120	30,950	929		
Drum, black	6,800	204	2,450	75		
Drum, red or redfish	6,000	360	6,465	405		
Flounders	900	72	1,290	106		
Grunts	75	2	2,900	71		
King whiting	1,250	63	1,168	58		
Mullet			615,700	21,498		
Pompano	200	40	520	106		
Sheepshead	4,500	270	14,940	1,035		
Spanish mackerel	800	80	385	39		
Spot	3,000	90	12,760	396		
Squeteague or "sea trout"	10,000	1,000	12,230	1,235	24,000	2,400
Crabs, hard					84,000	2,750
Shrimp	225,000	8,538				
Terrapin			2,332	933		
Total	269,125	10,957	718,350	27,414	109,800	5,240

Species	Otter trawls		Tongs	
	Pounds	*Value*	*Pounds*	*Value*
Shrimp	2,711,500	$101,674		
Oysters, market, public			906,227	$32,751
Oysters, market, private			725,375	53,968
Oysters, seed, public			630,000	13,500
Total	2,711,500	101,674	2,261,602	100,219

Summary of the yield

Species	Vessel fisheries		Shore fisheries		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Angelfish	200	$20	1,740	$52	1,940	$72
Bluefish			3,500	210	3,500	210
Blue runner or hardtail			1,200	36	1,200	36
Catfish			16,220	638	16,220	638
Croaker	1,650	66	34,950	1,049	36,600	1,115
Drum, black			9,250	279	9,250	279
Drum, red or redfish	2,300	184	12,465	765	14,765	949
Flounders			2,190	178	2,190	178
Groupers	304,600	7,615			304,600	7,615
Grunts			2,975	73	2,975	73
King whiting	180	13	2,418	121	2,598	134
Mullet	32,500	975	615,700	21,498	648,200	22,473
Pompano	50	13	720	146	770	159
Sheepshead	1,200	84	19,440	1,305	20,640	1,389
Snapper, red	970,000	77,600			970,000	77,600
Spanish mackerel			1,185	119	1,185	119
Spot			15,760	486	15,760	486
Squeteagues or "sea trout"	2,680	268	46,230	4,635	48,910	4,903
Crabs, hard			84,000	2,750	84,000	2,750
Shrimp	245,500	9,227	2,936,500	110,012	3,182,000	119,239
Oysters, market, public			906,227	32,751	906,227	32,751
Oysters, market, private			725,375	53,968	725,375	53,968
Oysters, seed, public			630,000	13,500	630,000	13,500
Terrapin			2,332	933	2,332	933
Total	1,560,860	96,065	6,070,377	245,504	7,631,237	341,569

Summary by counties

County	Persons engaged	Investment	Products	
	Number	*Dollars*	*Pounds*	*Value*
Baldwin	109	48,413	1,762,455	$67,179
Mobile	459	247,007	5,868,782	274,390
Total	568	295,420	7,631,237	341,569

MISSISSIPPI

The coastal fisheries of Mississippi in 1923 employed 1,700 persons, of whom 712 were on fishing vessels, 46 on transporting vessels, and 942 in the shore and boat fisheries. The investment amounted to $676,573 and included 143 fishing vessels with a total net tonnage of 1,992 tons, valued at $259,485 and carrying outfits valued at $22,028; 14 transporting vessels with a total net tonnage of 218 tons, valued at $22,500 and carrying outfits valued at $1,590; 379 sail and power boats, valued at $275,800; 479 rowboats, valued at $11,230; fishing apparatus on vessels valued at $33,987; fishing apparatus in the shore and boat fisheries valued at $32,503; and shore and accessory property valued at $17,450. The production of the fisheries amounted to 25,021,738 pounds, valued at $985,741. Oysters were the most important item in the yield, amounting to 11,874,954 pounds, valued at $472,652. Shrimp were next, amounting to 9,879,100 pounds, valued at $359,086. The production of mullet was 1,739,026 pounds, valued at $52,719, and that of squeteagues or "sea trout" was 410,294 pounds, valued at $37,327. Nineteen varieties of fish and shellfish of lesser importance made up the remainder of the yield.

Fisheries.—The vessel fisheries of Alabama employed haul seines, otter trawls, dredges, and tongs, which together produced 11,212,131 pounds of oysters and shrimp, valued at $394,695. Dredges produced 7,921,725 pounds of oysters, valued at $273,024; haul seines yielded 2,490,000 pounds of shrimp, valued at $88,997; otter trawls, 632,700 pounds of shrimp, valued at $22,819; and tongs 167,706 pounds of oysters, valued at $9,855.

The shore and boat fisheries produced 13,819,607 pounds of fish and shellfish, valued at $591,046. Otter trawls were the most productive apparatus, catching 6,312,800 pounds of shrimp, valued at $230,887. Tongs were next with 1,888,572 pounds of oysters, valued at $109,211. Trammel nets followed with 1,716,411 pounds of products, valued at $81,841, of which 1,094,914 pounds, valued at $33,256, were mullet; 245,894 pounds, valued at $22,157, were squeteagues or "sea trout," and the remainder was made up of 13 other varieties in smaller quantities. Dredges yielded 1,896,951 pounds of oysters, valued at $80,562. Haul seines produced 1,141,014 pounds of products, valued at $41,335, of which mullet was the most important item, with 610,612 pounds, valued at $18,318, followed by shrimp with 443,600 pounds, valued at $16,383. Lines yielded 706,369 pounds, valued at $34,262, the principal items of which were squeteagues or "sea trout," hard crabs, and sheepshead. Minor apparatus produced 157,490 pounds, valued at $12,940.

Wholesale trade and industries.—The wholesale fish trade was carried on by 24 establishments, valued at $80,440, with cash capital of $17,250 and employing 243 persons, to whom $63,989 were paid in wages.

Fish canning and the manufacture of by-products were carried on by 33 establishments, valued at $1,023,395, with cash capital of $116,050 and employing 1,556 persons, to whom $539,525 were paid in wages. The production consisted of 204,548 cases of canned oysters, valued at $1,057,201; 173,093 cases of canned shrimp, valued at $1,066,157; 32,789 tons of crushed oyster shells, valued at $278,031; and other products valued at $2,837; making the total value of canned fishery products and by-products $2,404,226.

The following tables and summary statements present the detailed statistics of the fisheries of Mississippi in 1924.[8]

Yield of the vessel fisheries of Mississippi in 1923, by species and apparatus

Species	Haul seines		Otter trawls		Dredges		Tongs	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Shrimp	2,490,000	$88,997	632,700	$22,819				
Oysters, market:								
Public, Mississippi					2,555,175	$84,614	65,352	$3,768
Private, Mississippi							15,750	1,125
Public, Louisiana					3,220,077	113,085	55,734	3,221
Private, Louisiana					2,146,473	75,325	30,870	1,741
Total	2,490,000	88,997	632,700	22,819	7,921,725	273,024	167,706	9,855

[8] For statistics on persons engaged, vessels, boats, gear, and investment in the fisheries refer to page 266.

Yield of the shore fisheries of Mississippi in 1923, by species and apparatus

Species	Haul seines		Trammel nets		Lines		Otter trawls	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Bluefish	3,800	$228	2,100	$186				
Catfish	1,300	52	16,140	506	18,000	$720		
Croaker	480	24	32,005	1,231	11,930	596		
Drum, black	1,700	68	36,589	1,171	700	24		
Drum, red or redfish	23,600	1,416	146,217	11,014	4,443	343		
Flounders	2,440	220	11,814	1,155	4,162	452		
Groupers					26,137	784		
Jewfish					5,200	156		
King whiting	2,920	146	6,134	395				
Mullet	610,612	18,318	1,094,914	33,256				
Pompano	5,376	1,075	1,675	361	105	26		
Porgies					400	12		
Sea bass	100	6	5,040	393	2,800	196		
Sheepshead	5,800	290	77,764	4,824	6,014	546		
Snapper, red					103,618	8,808		
Spanish mackerel	2,972	198	6,960	749	150	19		
Spot			25,965	866	1,080	40		
Squeteagues or "sea trout"	36,314	2,911	245,894	22,157	118,986	11,309		
Crabs, hard					402,644	10,231		
Shrimp	443,600	16,383					6,312,800	$230,887
Terrapin			7,200	3,585				
Total	1,141,014	41,335	1,716,411	81,849	706,369	34,262	6,312,800	230,887

Species	Cast nets		Spears		Dip nets	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Croaker	600	$30				
Drum, red or redfish	2,500	206				
Flounders			69,200	$7,092		
Menhaden	400	20				
Mullet	33,500	1,145				
Sheepshead	1,190	111				
Spot	200	6				
Squeteagues or "sea trout"	9,100	950				
Crabs, hard					32,000	$1,200
Crabs, soft					2,000	375
Total	47,490	2,468	69,200	7,092	34,000	1,575

Species	Dredges		Tongs		By hand	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Oysters, market:						
Public, Mississippi	767,172	$31,585	1,240,701	$72,975		
Private, Mississippi			87,486	7,280		
Public Louisiana	694,659	30,026	447,132	23,073		
Private, Louisiana	435,120	18,951	113,253	5,883		
Crabs, soft					6,800	$1,805
Total	1,896,951	80,562	1,888,572	109,211	6,800	1,805

Summary of the yield

Species	Vessel fisheries		Shore fisheries		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Bluefish			5,900	$414	5,900	$414
Catfish			35,440	1,278	35,440	1,278
Croaker			45,015	1,881	45,015	1,881
Drum, black			38,989	1,263	38,989	1,263
Drum, red, or redfish			176,760	12,979	176,760	12,979
Flounders			87,616	8,919	87,616	8,919
Groupers			26,137	784	26,137	784
Jewfish			5,200	156	5,200	156
King whiting			9,054	541	9,054	541
Menhaden			400	20	400	20
Mullet			1,739,026	52,719	1,739,026	52,719
Pompano			7,156	1,462	7,156	1,462
Porgies			400	12	400	12
Sea bass			7,940	595	7,940	595
Sheepshead			90,768	5,771	90,768	5,771
Snapper, red			103,618	8,808	103,618	8,808
Spanish mackerel			10,082	966	10,082	966
Spot			27,245	912	27,245	912
Squeteagues or "sea trout"			410,294	37,327	410,294	37,327
Crabs, hard			434,644	11,431	434,644	11,431
Crabs, soft			8,800	2,180	8,800	2,180
Shrimp	3,122,700	$111,816	6,756,400	247,270	9,879,100	359,086
Oysters, market:						
Public, Mississippi	2,620,527	88,382	2,007,873	104,560	4,628,400	192,942
Private, Mississippi	15,750	1,125	87,486	7,280	103,236	8,405
Public, Louisiana	3,275,811	116,306	1,141,791	53,099	4,417,602	169,405
Private, Louisiana	2,177,343	77,066	548,373	24,834	2,725,716	101,900
Terrapin			7,200	3,585	7,200	3,585
Total	11,212,131	394,695	13,819,607	591,046	25,031,738	985,741

Summary by counties

County	Persons engaged	Investment	Products	
	Number	*Dollars*	*Pounds*	*Value*
Hancock	83	27,985	555,408	$30,813
Harrison	1,377	590,441	21,629,595	828,930
Jackson	240	58,147	2,846,735	125,998
Total	1,700	676,573	25,031,738	985,741

LOUISIANA

The coastal fisheries of Louisiana in 1923 employed 2,611 persons, of whom 144 were on fishing vessels, 146 on transporting vessels, and 2,321 in the shore and boat fisheries. The investment amounted to $1,385,696. Included in this investment were 59 fishing vessels, with a total net tonnage of 394 tons, valued at $109,100 and with outfits valued at $15,046; 71 transporting vessels, with a total net tonnage of 554 tons, valued at $149,100 and with outfits to the value of $10,070; 1,141 power boats, valued at $919,400; 577 rowboats, valued at $18,310; fishing apparatus on vessels valued at $2,529; fishing apparatus in the shore and boat fisheries, valued at $101,361; and shore and accessory property valued at $60,780. The total production of the fisheries amounted to 34,835,194 pounds, valued at $1,961,100. In this production shrimp was the most important item, consisting of 24,881,985 pounds, valued at $984,069; oysters followed with 7,154,763 pounds, valued at $770,434; squeteagues or "sea trout" were next with 783,214 pounds, valued at $73,031; red drum or redfish with 665,067 pounds, valued at $55,941; and 19 other less important varieties of fish and shellfish.

Fisheries.—The vessel fisheries employed otter trawls, dredges, and tongs, which yielded 3,093,132 pounds of shrimp and oysters,

valued at $229,949. Dredges were most important, producing 1,352,232 pounds of oysters, valued at $149,079. Tongs yielded 220,500 pounds of oysters, valued at $22,750, and otter trawls yielded 1,520,400 pounds of shrimp, valued at $58,120.

The shore and boat fisheries yielded 31,742,062 pounds of fish and shellfish, valued at $1,731,151. Otter trawls produced the most valuable catch, consisting of 19,564,437 pounds of shrimp, valued at $776,825. Tongs were next with a yield of 5,018,181 pounds of oysters, valued at $535,230. Haul seines followed with 5,020,466 pounds of fish and shellfish, valued at $241,143, of which 3,785,148 pounds, valued at $148,404, were shrimp; 375,951 pounds, valued at $34,478, were squeteagues or "sea trout"; 318,832 pounds, valued at $27,268, were red drum; the remainder being made up of 16 other varieties of fish and shellfish. Trammel nets yielded 924,008 pounds of fish and shellfish, valued at $73,808; dredges took 563,850 pounds of oysters, valued at $63,375; lines, 589,220 pounds of fish and shellfish, valued at $35,395; and 61,900 pounds of crabs, shrimp, and terrapin were taken with cast nets, dip nets, and by hand.

Wholesale trade and industries.—The wholesale fish trade was conducted by 21 establishments, valued at $196,645, which had a cash capital of $34,250 and employed 388 persons, to whom $177,898 was paid in wages.

Fish canning and the manufacture of by-products were carried on by 36 establishments, valued at $869,506, having a cash capital of $120,200 and employing 2,159 persons, to whom $331,303 was paid in wages. The total output of these industries was valued at $2,309,617, consisting of 292,689 cases of canned shrimp, valued at $1,811,747; 428,894 pounds of dried shrimp, valued at $115,541; 834 tons of shrimp bran, valued at $26,165, and other fishery products to the value of $356,164.

The following tables and summary statements present the detailed statistics of the fisheries of Louisiana in 1924.[9]

Yield of the shore fisheries of Louisiana in 1923, by apparatus and species

Species	Haul seines		Trammel nets		Lines	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Catfish	54,210	$2,223	27,405	$780	23,120	$928
Croakers	107,995	6,078	73,315	4,071	37,715	2,405
Drum, black	39,550	1,347	18,538	562	1,900	91
Drum, red or redfish	318,832	27,268	316,535	26,297	29,700	2,376
Flounders	7,830	736	5,843	374	7,840	780
Groupers					10,000	500
Mullet	143,635	5,037	37,850	1,115		
Pompano	470	81	750	137		
Sea bass	1,870	150				
Sea gar, dried	1,150	92				
Sheepshead	121,255	8,156	61,024	5,238	11,065	1,041
Snapper, red					175,000	17,500
Spanish mackerel	920	125	1,680	236		
Spot	15,550	470	7,885	359		
Squeteagues or "sea trout"	375,951	34,478	356,983	33,855	50,280	4,698
Yellowtail	450	11	2,050	61		
Crabs, hard	30,000	1,200			242,600	5,076
Crabs, soft	2,000	750				
Shrimp, green	3,756,940	141,502				
Shrimp, dried	28,208	6,902				
Squid	300	30	5,500	550		
Terrapin	13,350	4,507				
Turtles			8,650	173		
Total	5,020,466	241,143	924,008	73,808	589,220	35,395

[9] For statistics on persons engaged, vessels, boats, gear, and investment in the fisheries refer to page 267.

Yield of the shore fisheries of Louisiana in 1923, by apparatus and species—Con.

Species	Cast nets		Dip nets		Otter trawls	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Shrimp, green	12,000	$720			19,182,528	$700,443
Shrimp, dried					381,909	76,382
Crabs, hard			40,000	$1,350		
Crabs, soft			1,000	300		
Total	12,000	720	41,000	1,650	19,564,437	776,825

Species	Dredges		Tongs		By hand	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Oysters, market, public			1,272,285	$151,462		
Oysters, market, private	563,850	$63,375	3,745,896	383,768		
Terrapin					8,900	$3,005
Total	563,850	63,375	5,018,181	535,230	8,900	3,005

Summary of the yield

Species	Vessel fisheries		Shore fisheries		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Catfish			114,735	$3,731	114,735	$3,931
Croaker			219,025	12,554	219,025	12,554
Drum, black			59,988	2,000	59,988	2,000
Drum, red or redfish			665,067	55,941	665,067	55,941
Flounders			21,513	1,890	21,513	1,890
Groupers			10,000	500	10,000	500
Mullet			181,485	6,152	181,485	6,152
Pompano			1,220	218	1,220	218
Sea bass			1,870	150	1,870	150
Sea gar, dried			1,150	92	1,150	92
Sheepshead			193,344	14,435	193,344	14,435
Snapper, red			175,000	17,500	175,000	17,500
Spanish mackerel			2,600	361	2,600	361
Spot			23,435	829	23,435	829
Squeteagues or "sea trout"			783,214	73,031	783,214	73,031
Yellowtail			2,500	72	2,500	72
Crabs, hard			312,600	7,626	312,600	7,626
Crabs, soft			3,000	1,050	3,000	1,050
Shrimp, green	1,520,400	$58,120	22,951,468	842,665	24,471,868	900,785
Shrimp, dried			410,117	83,284	410,117	83,284
Oysters, market, public			1,272,285	151,462	1,272,285	151,462
Oysters, market, private	1,572,732	171,829	4,309,746	447,143	5,882,478	618,972
Squid			5,800	580	5,800	580
Terrapin			22,250	7,512	22,250	7,512
Turtles			8,650	173	8,650	173
Total	3,093,132	229,949	31,742,062	1,731,151	34,835,194	1,961,100

Summary by counties

County	Persons engaged	Investment	Products	
	Number	*Dollars*	*Pounds*	*Value*
Calcasieu	9	3,055	13,460	$1,291
Iberia	23	10,224	202,109	15,419
Jefferson	610	297,715	11,852,054	509,520
Jefferson Davis	12	1,770	27,235	1,531
La Fourche	389	239,205	5,770,006	325,855
Orleans	229	125,000	2,341,971	196,075
Plaquemines	383	198,665	4,412,015	258,658
St. Bernard	157	22,235	846,183	45,000
St. Mary	123	88,079	815,763	77,800
St. Tammany	22	5,615	65,710	5,360
Terrebonne	604	381,701	8,063,424	496,943
Vermilion	50	12,432	425,264	27,648
Total	2,611	1,385,696	34,835,194	1,961,100

TEXAS

The coastal fisheries of Texas in 1923 gave employment to 1,399 persons, of whom 261 were on fishing vessels, 16 on transporting vessels, and 1,122 in the shore and boat fisheries. The investment in the fisheries amounted to $567,114. Included in this investment were 32 fishing vessels with a total net tonnage of 797 tons, valued at $229,900, and with outfits, valued at $34,800; 6 transporting vessels with a total net tonnage of 39 tons, valued at $3,850, and with outfits, valued at $440; 250 power boats, valued at $135,400; 115 sailboats, valued at $59,300; 408 rowboats, valued at $12,250; fishing apparatus on vessels, valued at $10,898; fishing apparatus in the shore and boat fisheries, valued at $65,176; and shore and accessory property, valued at $15,100. The yield of the fisheries was 19,559,608 pounds of fish and shellfish, valued at $782,013. The most important items, given in order of value, were oysters, 2,519,846 pounds, valued at $176,076; shrimp, 3,421,638 pounds, valued at $158,519; squeteagues or "sea trout," 1,523,965 pounds, valued at $154,238; red snapper, 1,008,960 pounds, valued at $80,717; red drum or redfish, 877,760 pounds, valued at $72,299; menhaden, 8,517,000 pounds, valued at $56,780; and black drum, 1,028,451 pounds, valued at $36,807.

Fisheries.—The vessel fisheries produced 10,062,435 pounds of fish and shellfish, valued at $168,663. Lines produced the most valuable yield, consisting of 1,047,635 pounds of red snapper, grouper, and jewfish, valued at $81,875. Purse seines yielded 8,517,000 pounds of menhaden, valued at $56,780. Haul seines, trammel nets, otter trawls, dredges, and tongs each yielding products valued under $15,000, took the remainder of the catch.

The shore and boat fisheries produced 9,497,171 pounds, valued at $613,350. The most valuable yield was by haul seines and consisted of 2,618,862 pounds, valued at $174,023, of which squeteagues or "sea trout," red drum or redfish, black drum, and shrimp were the largest items. Otter trawls were next, with 2,965,110 pounds of shrimp and crabs, valued at $137,617. Tongs followed with 1,849,946 pounds of oysters, valued at $131,825. Trammel nets yielded 692,998 pounds, valued at $63,851, consisting largely of squeteagues or "sea trout," and red drum or redfish; gill nets caught 540,190 pounds, valued at $39,635, also consisting mostly of squeteagues and drum. Lines caught 358,865 pounds, valued at $33,157, of which squeteagues, Spanish mackerel, and crabs were important items; dredges produced 389,900 pounds of oysters, valued at $26,334; and 81,300 pounds of flounders, valued at $6,906, were caught with spears.

Wholesale trade and industries.—The wholesale fishery trade was conducted by 33 establishments, valued at $288,948, with cash capital of $59,830, and employing 449 persons, to whom $116,289 were paid in wages.

Fish canning and by-products manufacture were carried on by 8 establishments, valued at $223,296, with cash capital of $45,000 and employing 249 persons, to whom $51,023 were paid in wages. The total output was valued at $172,558, of which $72,232 was the value of canned shrimp and oysters and $100,326 the value of other products and by-products.

The following tables and summary statements present the detailed statistics of the fisheries of Texas in 1924.[10]

Yield of the vessel fisheries of Texas in 1923, by apparatus and species

Species	Purse seines		Haul seines		Trammel nets		Lines	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Catfish			260	$10	150	$4		
Croaker			740	36	300	13		
Drum, black			7,850	329	550	33		
Drum, red or redfish			11,150	945	3,600	360		
Flounders			300	27				
Groupers							32,725	$980
Jewfish							5,950	178
King whiting			885	71	865	60		
Menhaden	8,517,000	$56,780						
Mullet			300	12	120	5		
Pompano			125	13				
Sheepshead			2,780	220	375	30		
Snapper, red							1,008,960	80,717
Spanish mackerel			50	6				
Squeteagues or "sea trout"			21,450	2,244	3,300	396		
Shrimp			61,050	2,763				
Total	8,517,000	56,780	106,940	6,676	9,260	901	1,047,635	81,875

Species	Otter trawls		Dredges		Tongs	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Shrimp	101,600	$4,514				
Oysters, market, public			59,500	$3,542	220,500	$14,375
Total	101,600	4,514	59,500	3,542	220,500	14,375

Yield of the shore fisheries of Texas in 1923, by apparatus and species

Species	Haul seines		Trammel nets		Gill nets		Lines	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Bluefish							500	$85
Catfish	17,965	$872	3,995	$212	4,250	$213	23,720	1,303
Croaker	42,745	2,084	8,810	383	13,660	683	1,715	89
Drum, black	819,161	29,364	66,440	2,889	126,800	3,869	7,650	323
Drum, red or redfish	504,920	41,237	200,925	16,947	109,500	8,760	47,665	4,050
Flounders	33,570	2,974	1,630	148	800	80	[1] 82,095	[1] 6,974
Jewfish							7,500	375
King whiting	3,898	317	2,805	241			2,950	326
Mullet	6,490	229	633	28				
Pompano	2,105	236			250	25	50	13
Sea gar	15,400	1,232			10,750	860		
Sheepshead	80,570	4,474	28,705	1,877	23,930	1,207	4,250	309
Spanish mackerel	4,650	558					74,220	7,663
Squeteagues or "sea trout"	770,110	75,846	379,055	41,126	250,250	23,938	99,800	10,688
Crabs, hard	3,400	102					85,500	7,688
Shrimp	313,878	14,498						
Turtles							2,550	204
Total	2,618,862	174,023	692,998	63,851	540,190	39,635	440,165	40,063

Species	Otter trawls		Dredges		Tongs		By hand	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Crabs, hard	20,000	$875						
Shrimp	2,945,110	136,744						
Oysters, market, public			389,900	$26,334	1,798,272	$127,039	30,674	$3,286
Oysters, market, private					21,000	1,500		
Total	2,965,110	137,619	389,900	26,334	1,819,272	128,539	30,674	3,286

[1] Includes 81,300 pounds, valued at $6,906, taken by spears.

[10] For statistics on persons engaged, vessels, boats, gear, and investment in the fisheries refer to page 267.

Summary of the yield

Species	Shore fisheries		Vessel fisheries		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Bluefish	500	$85			500	$85
Catfish	49,930	2,600	410	$14	50,340	2,614
Croaker	66,930	3,239	1,040	49	67,970	3,288
Drum, black	1,020,051	36,445	8,400	362	1,028,451	36,807
Drum, red or redfish	863,010	70,994	14,750	1,305	877,760	72,299
Flounders	118,095	10,176	300	27	118,395	10,203
Groupers			32,725	980	32,725	980
Jewfish	7,500	375	5,950	178	13,450	553
King whiting	9,653	884	1,750	131	11,403	1,015
Menhaden			8,517,000	56,780	8,517,000	56,780
Mullet	7,123	257	420	17	7,543	274
Pompano	2,405	274	125	13	2,530	287
Sea gar	26,150	2,092			26,150	2,092
Sheepshead	137,455	7,867	3,155	250	140,610	8,117
Snapper, red			1,008,960	80,717	1,008,960	80,717
Spanish mackerel	78,870	8,194	50	6	78,920	8,200
Squeteagues or "sea trout"	1,499,215	151,598	24,750	2,640	1,523,965	154,238
Crabs, hard	108,900	8,665			108,900	8,665
Shrimp	3,258,988	151,242	162,650	7,277	3,421,638	158,519
Oysters, market, public	2,218,846	156,659	280,000	17,917	2,498,846	174,576
Oysters, market, private	21,000	1,500			21,000	1,500
Turtles	2,550	204			2,550	204
Total	9,497,171	613,350	10,062,435	168,663	19,559,606	782,013

Summary by counties

County	Persons engaged	Investment	Products	
	Number	*Dollars*	*Pounds*	*Value*
Aransas	124	26,599	973,979	$76,269
Brazoria	21	2,489	34,175	2,827
Calhoun	164	36,496	1,054,177	80,163
Cameron	140	43,070	667,824	41,438
Chambers	30	4,912	45,840	3,682
Galveston	215	132,553	2,678,681	190,184
Harris	34	5,994	198,640	17,580
Jefferson	168	144,968	8,543,605	58,969
Matagorda	130	48,136	1,156,526	81,591
Nueces	288	93,578	3,468,391	184,411
Orange	6	180	5,950	376
San Patricio	79	28,139	731,818	44,523
Total	1,399	567,114	19,559,606	782,013

FISHERIES OF THE NEW ENGLAND STATES IN 1924

The statistics in this report apply to the coast fisheries of the New England States for the calendar year 1924 and have been published in condensed form in Statistical Bulletin No. 703 and distributed to the trade. The canvass was made by W. A. Roberts, Rob Leon Greer, and Carl B. Tendick, agents of the bureau, assisted by temporary employees. The bureau thanks the respective State fisheries officials for their kindness in making their records available to these agents and otherwise cooperating to facilitate the obtaining of information in this canvass.

In so far as possible, the canvass was conducted similarly to that taken of the fisheries of the New England States for 1919, in order that the statistics might be comparable to those previously collected.[11]

[11] The statistical reports published by the Bureau of Fisheries on the fisheries of the coastal States include the commercial fisheries of the ocean, bays, and estuaries, and also the river fisheries up as far as anadromous fishes are commercially important. The statistics are for the calendar year, except those of the oyster yield, which are for the oyster

EARLIER PUBLICATIONS

Some of the earlier publications relating to the fisheries of the New England States, published in Washington, D. C., follow:

1873. Report on the Condition of the Sea Fisheries of the South Coast of New England in 1871 and 1872. By Spencer F. Baird. Report, U. S. Commissioner of Fish and Fisheries, 1871 and 1872 (1873), p. i–xli.

1887. The Coast of Maine and its Fisheries. By R. Edward Earll. *In* The Fisheries and Fishery Industries of the United States, by G. Brown Goode, et al., Sec. II, Pt. I, p. 5–102.

The Fisheries of New Hampshire. By W. A. Wilcox. Ibid., Sec. II, Pt. II, p. 103–112.

1887. The Fisheries of Massachusetts. By A. Howard Clark. Ibid., Sec. II, Pt. III, p. 113–280.

The Fisheries of Rhode Island. By A. Howard Clark. Ibid., Sec. II, Pt. IV, p. 281–310.

The Coast of Connecticut and Its Fisheries. By A. Howard Clark. Ibid., Sec. V, p. 311–340.

History and Methods of the Fisheries. Ibid., Sec. V, Vol. I (xi+808 pp.), Vol. II (xx+881 pp.), and atlas of 275 pls.

1889. The Sea Fisheries of Eastern North America. By Spencer F. Baird. Appendix A, Report, U. S. Commissioner of Fish and Fisheries, 1886 (1889), 224 pp.

1891. Notes on the Oyster Fishery of Connecticut. By J. W. Collins. Bulletin, U. S. Fish Commission, Vol. IX, 1889 (1891), pp. 461–497, pls. CLIX–CLXVI.

1892. III. Fisheries of the New England States [1887 and 1888]. *In* Statistical Review of the Coast Fisheries of the United States, prepared under the direction of J. W. Collins. Report, U. S. Commissioner of Fish and Fisheries, 1888 (1892), pp. 286–322.

Report on the Fisheries of the New England States. By J. W. Collins and Hugh M. Smith. Bulletin, U. S. Fish Commission, Vol. X, 1890 (1892), pp. 73–176.

1898. The Herring Industry of the Passamaquoddy Region, Maine. By Ansley Hall. Report, U. S. Commissioner of Fish and Fisheries, 1896 (1898), pp. 443–487.

1899. The Shad Fisheries of the Atlantic Coast of the United States. By Charles H. Stevenson. Report, U. S. Commissioner of Fish and Fisheries, 1898 (1899), pp. 101–269.

1901. The Lobster Fishery of Maine. By John N. Cobb. Bulletin, U. S. Fish Commission, Vol. XIX, 1899 (1901), pp. 241–265, illus., pls. 28–32.

Statistics of the Fisheries of the New England States. Report, U. S. Commissioner of Fish and Fisheries, 1900 (1901), pp. 311–386.

1905. Statistics of the Fisheries of the New England States, 1902. Report, U. S. Bureau of Fisheries, 1904 (1905), pp. 245–325.

1907. Statistics of the Fisheries of the New England States for 1905. Report, U. S. Commissioner of Fisheries, 1906 (1908), 93 pp. Bureau of Fisheries Document No. 620.

1911. Fisheries of the United States, 1908. Special Reports, Bureau of the Census, 1911.

1921. Fishery Industries of the United States. Report of the Division of Statistics and Methods of the Fisheries for 1920. By Lewis Radcliffe. Appendix V, Report of the U. S. Commissioner of Fisheries for 1921, Bureau of Fisheries Document No. 908, pp. 120–180.

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season that ended in the calendar year for which the statistics were collected. The values given are those received by the fishermen. The vessel fisheries are conducted by vessels and the shore fisheries are carried on with or without boats. Vessels include all craft of 5 net tons and upward, as measured by the United States Customs Service, and boats include all craft under 5 net tons. All statistics except those of the oyster yield are credited to the State and county in which the fishermen have their home ports. The oyster yield is credited to the State from the waters of which the oysters were taken.

COMMON AND SCIENTIFIC NAMES

Following is a list of the common and scientific names of the fishes of the New England States that occur in the tables and discussion in the present report.

Alewives	*Pomolobus æstivalis.* *Pomolobus pseudoharengus.*
Bluefish	*Pomatomus saltatrix.*
Bonito	*Sarda sarda.*
Bullhead	*Ameiurus nebulosus.*
Butterfish	*Poronotus triacanthus.*
Carp, German	*Cyprinus carpio.*
Cod	*Gadus callarias.*
Cunner	*Tautogolabrus adspersus.*
Cusk	*Brosmius brosme.*
Eels	*Anguilla rostrata.* *Leptocephalus conger.*
Flounders	Pleuronectidæ (species).
Goosefish	*Lophius piscatorius.*
Grayfish	*Squalus acanthias.* *Mustelus canis.*
Haddock	*Melanogrammus æglifinus.*
Hake	*Urophycis tenuis.* *Urophycis chuss.*
Halibut	*Hippoglossus hippoglossus.*
Herring	*Clupea harengus.*
Hickory shad	*Pomolobus mediocris.*
Mackerel	*Scomber scombrus.*
Menhaden	*Brevoortia tyrannus.*
Mummichog	Fundulus (species).
Perch, white	*Morone americana.*
Perch, yellow	*Perca flavescens.*
Pickerel	*Esox reticulatus.*
Pollock	*Pollachius virens.*
Pompano	Trachinotus (species).
Roach or shiner	*Abramis crysoleucas.*
Rosefish	*Sebastes marinus.*
Salmon, Atlantic	*Salmo salar.*
Sculpins	Cottidæ (species).
Scup	*Stenotomus chrysops.*
Sea bass	*Centropristes striatus.*
Sea robin	*Prionotus carolinus.* *Prionotus strigatus.*
Shad	*Alosa sapidissima.*
Sharks	Selachii (species).
Skates and rays	Batoidei (species).
Smelt	*Osmerus mordax.*
Squeteague	*Synoscion regalis.*
Striped bass	*Roccus lineatus.*
Sturgeon	*Acipenser sturio.*
Suckers	Catostomidæ (species).
Swordfish	*Xiphias gladius.*
Tautog	*Tautoga onitis.*
Tilefish	*Lopholatilus chamæleonticeps.*
Tomcod	*Microgadus tomcod.*
Tuna or horse mackerel	*Thunnus thynnus.*
Whitebait	Various species small fishes.
Whiting	*Merluccius bilinearis.*
Wolffish	*Anarhichas lupus.*
Lobsters	*Homarus americanus.*
Shrimp	*Crangon vulgaris.*
Crabs, hard	*Callinectes sapidus.* *Cancer borealis.* *Cancer irroratus.*

Crabs, sand	*Platyonichus ocellatus.*
Squid	*Ommastrephes illecebrosus.*
	Loligo (species).
Clams, hard	*Venus mercenaria.*
Clams, soft	*Mya arenaria.*
Clams, razor	*Eusatella americana.*
Oysters	*Ostrea elongata.*
Scallops	*Pecten irradiaus.*
Scallops, sea	*Pecten magellanicus.*
Cockles and winkles	*Buccinum undatum.*
	Lunatia (species).
	Littorina littorea.
Irish moss	*Chondrus crispus.*

GENERAL STATISTICS

The fisheries and fishery industries of the New England States in 1924 gave employment to 24,513 persons, of whom 15,983 were engaged in fishing operations, 1,922 in the wholesale fishery trade, and 6,608 in the canning, salting, smoking, and by-products industries. The investment amounted to $28,561,824. Of this amount $14,984,327 were invested in vessels, boats, fishing apparatus, and shore and accessory property used by the fishermen; $6,089,306 in property and cash capital in the wholesale fishery trade; and $7,488,191 in property and cash capital in the canning, salting, smoking, and by-products industries. The yield of the fisheries aggregated 406,822,165 pounds, valued at $18,818,132. The output of the canning, salting, smoking, and by-products industries was valued at $14,253,831.

Massachusetts ranked first among the New England States in the importance of its fisheries with 9,275 persons employed, $15,362,016 invested, and 243,362,693 pounds of fishery products, having a value (as sold by the fishermen) of $10,799,598. Maine was next in importance, with 11,942 persons employed, $9,406,334 invested, and fishery products amounting to 116,707,179 pounds, having a value to the fishermen of $4,136,989. New Hampshire had 145 persons engaged in the fisheries and fishery industries, $68,315 invested, and fishery products amounting to 447,450 pounds, valued at $56,029. In Rhode Island 1,469 persons were thus employed, $1,666,587 were invested, and 20,535,327 pounds of fishery products, valued at $1,818,858, were taken. The fisheries of Connecticut gave employment to 1,682 persons, the investment amounted to $2,058,572, and the products of the fisheries to 25,769,516 pounds, valued at $2,006,658.

The most important product of the New England fisheries in 1924, in its value to the fishermen, was the cod, the catch of which amounted to 89,218,355 pounds, valued at $3,075,965, or 16.35 per cent of the total value of the fishery products taken in these States. The species that ranked next in value was the lobster, the catch of which amounted to 9,716,196 pounds, valued at $3,072,411. The catch of lobsters, by States, was as follows:

States	Pounds	Value
Maine	5,513,002	$1,772,165
New Hampshire	125,600	40,000
Massachusetts	1,679,601	557,437
Rhode Island	1,696,346	462,000
Connecticut	701,647	240,809
Total	9,716,196	3,072,411

Some of the other more important products, in the order of their value, were haddock, 93,518,826 pounds, valued at $2,656,900; oysters, 11,301,829 pounds, or 1,614,547 bushels, valued at $2,070,006; mackerel, 26,653,363 pounds, valued at $1,519,438; flounders, 30,854,736 pounds, valued at $1,339,076; clams, 7,961,000 pounds, or 838,069 bushels, valued at $1,065,531; halibut, 4,500,931 pounds, valued at $788,925; herring, 60,235,656 pounds, valued at $661,679; swordfish, 2,882,214 pounds, valued at $527,726; scallops, 1,267,506 pounds or 211,251 bushels, valued at $407,541; hake, 18,499,317 pounds, valued at $306,941; pollock, 8,294,896 pounds, valued at $220,747; and smelt 688,400 pounds, valued at $152,885. The remaining products aggregated 41,228,940 pounds, valued at $952,361, or about 10 per cent of the quantity and 5 per cent of the value of the total production.

Compared with 1919, the latest previous year for which complete statistics of the fisheries of this section were collected, there was a decrease of 6,254, or 20.33 per cent, in the number of persons engaged; $12,035,273, or 29.65 per cent, in the amount of capital invested; 60,517,705 pounds, or 12.95 per cent, in the quantity and $1,020,525, or 5.14 per cent, in the value of the products landed by the fishermen.

Comparisons of the yield of certain important fisheries with those of previous years give interesting indications of the trend of the New England fisheries. Statistics on total yield are available for 35 years back. Unfortunately, however, the canvasses were taken only at intervals of from 3 to 11 years, and as nothing is known of conditions in the intervening years, any conclusions that might be drawn from the records must be accepted with reservations. The cod fishery apparently maintained a fairly uniform yield during this period. The 1924 total was somewhat higher than that of 1919 but was below some of the previously recorded yields.

The haddock fishery has increased considerably in recent years and is now nearly equal in importance to the cod fishery. In 1924 the yield was the highest on record and was approximately twice as large as the totals recorded in the latter part of the nineteenth century. The flounder fishery increased from a minor fishery yielding less than 3,000,000 pounds in 1899 to one of major importance in 1924, with a yield of over 30,000,000 pounds. Hake and pollock showed considerable growth during the first half of the period considered, but declined considerably in recent years. The same may be said of the alewife. The herring and mackerel fisheries both have been subject to fluctuations of such magnitude that no clearly defined trend can be recognized, although the yields of mackerel in recent years have been larger. The halibut and shad fisheries both show a decided downward trend, the present yield being only half as large as those recorded in earlier years. The yield of swordfish in 1924 was more than double that of 1919 but below the record yield in 1908. The yield of whiting in 1924 was only half as large as that in 1919 but considerably above any previous records. The lobster fishery shows an almost continuous decrease from over 30,000,000 pounds in 1889 to less than 10,000,000 pounds in 1924. Soft clams also have decreased considerably in recent years, although in 1924 the catch

was substantially above that of 1919. The 1924 output of hard clams was the largest on record and was over three times as large as that of 1889.

Fisheries of the New England States, 1924

PERSONS ENGAGED

How engaged	Maine	New Hampshire	Massachusetts	Rhode Island	Connecticut	Total
On vessels fishing	739	2	3,087	334	574	4,736
On vessels transporting	226	4	29	2	17	278
In shore or boat fisheries	4,988	93	3,643	840	707	10,271
Shoresmen	299	35	364			698
Total	6,252	134	7,123	1,176	1,298	15,983

INVESTMENT

Item	Maine		New Hampshire		Massachusetts	
	Number	*Value*	*Number*	*Value*	*Number*	*Value*
Vessels fishing:						
Steam	8	$560,000			21	$1,091,989
Tonnage	1,546				2,096	
Outfit		47,850				245,619
Motor	93	418,950	1	$500	294	4,019,817
Tonnage	1,139		5		8,895	
Outfit		133,313		250		930,293
Sail	3	23,940			2	33,800
Tonnage	243				195	
Outfit		10,650				5,000
Vessels transporting:						
Steam	1	11,000			1	3,000
Tonnage	26				15	
Outfit		2,500				250
Motor	124	416,497	2	9,500	14	96,000
Tonnage	1,318		21		347	
Outfit		117,372		2,125		7,025
Sail	1	4,300			1	750
Tonnage	50				16	
Outfit		100				25
Boats, sail, row, etc	1,989	52,527	33	1,100	1,780	60,730
Boats, motor	2,684	951,205	39	10,000	1,608	770,640
Haul seines	106	16,605			20	2,750
Purse seines	48	36,275			86	116,675
Set nets	45	39,630				
Gill nets	2,108	51,106			8,437	115,547
Pound nets, trap nets, and weirs	387	248,300			218	332,300
Fyke nets	234	4,544			36	555
Bag nets and pocket nets	150	12,270				
Otter trawls	18	3,970			240	30,325
Lines, hand and trawl		51,970		595		79,130
Harpoons		2,025				7,165
Spears	22	45	15	30	75	120
Eel pots and traps	394	908	15	30	1,485	3,499
Sluiceways and traps	7	630				
Lobster pots	154,898	404,411	1,750	5,250	48,868	131,784
Crab pots					1,075	2,925
Dredges and drags	87	7,530			2,546	17,923
Tongs					197	1,346
Forks, rakes, shovels, and hoes	1,247	1,480	29	35	1,200	6,016
Minor apparatus		136		100		642
Shore and accessory property		160,836		3,900		315,358
Total		3,792,875		33,415		8,428,998

Fisheries of the New England States, 1924—Continued

Item	Rhode Island		Connecticut		Total	
	Number	*Value*	*Number*	*Value*	*Number*	*Value*
Vessels fishing:						
Steam	10	$106,200	25	$480,200	64	$2,238,389
Tonnage	257		2,250		6,149	
Outfit		27,585		149,225		470,279
Motor	65	239,180	83	301,590	536	4,980,037
Tonnage	736		1,103		11,878	
Outfit		42,513		40,842		1,147,211
Sail			10	7,300	15	65,040
Tonnage			67		505	
Outfit				415		16,065
Vessels transporting:						
Steam			1	4,000	3	18,000
Tonnage			18		59	
Outfit				1,250		4,000
Motor	6	13,500	8	12,350	154	547,847
Tonnage	59		86		1,831	
Outfit		375		1,295		128,192
Sail			[1] 3	12,000	5	17,050
Tonnage			371		437	
Outfit				200		325
Boats, sail, row, etc	482	18,977	511	25,605	4,795	158,939
Boats, motor	511	229,800	385	263,075	5,227	2,224,720
Haul seines	22	2,042	23	2,297	171	23,694
Purse seines	15	5,750	5	4,250	154	162,950
Set nets					45	39,630
Gill nets	608	10,509	95	5,650	11,248	182,812
Pound nets, trap nets, and weirs	127	183,100	38	9,785	770	773,485
Fyke nets	132	1,880	315	3,043	717	10,022
Bag nets and pocket nets					150	12,270
Otter trawls	42	2,010	87	3,830	387	40,135
Lines, hand and trawl		2,011		833		134,539
Harpoons		1,540		545		11,275
Spears	36	50	25	49	173	294
Eel pots and traps	1,055	689	1,282	1,156	4,231	6,282
Sluiceways and traps					7	630
Lobster pots	34,378	58,856	16,768	21,210	256,662	621,511
Crab pots			75	75	1,150	3,000
Dredges and drags	805	5,591	344	7,741	3,782	38,785
Tongs	239	1,385	103	523	539	3,254
Forks, rakes, shovels, and hoes	205	1,009	90	206	2,771	8,746
Minor apparatus		95		111		1,084
Shore and accessory property		180,920		232,821		893,835
Total		1,135,567		1,593,472		14,984,327

[1] Includes two barges.

Fisheries of the New England States, 1924—Continued.

PRODUCTS

Species	Maine		New Hampshire		Massachusetts	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives, fresh	1,503,075	$8,619			2,146,904	$22,708
Alewives, salted	7,200	126			296,930	8,662
Alewives, smoked	34,734	2,577				
Bluefish					61,176	15,843
Bonito					13,267	1,192
Butterfish	11,873	1,133			377,929	42,025
Cod, fresh	20,376,007	529,169	97,760	$3,860	62,615,980	2,250,383
Cod, salted	1,033,730	45,635			3,199,061	147,650
Cusk, fresh	1,567,029	27,558	600	10	2,600,008	52,018
Cusk, salted	1,055	26			58,140	1,381
Eels	157,351	17,469	6,200	710	413,732	38,874
Flounders	343,303	13,623			22,996,081	1,009,031
Grayfish					17,850	320
Haddock, fresh	15,457,794	356,195	143,680	5,765	77,683,384	2,286,869
Haddock, salted	49,460	1,027			323	8
Haddock, smoked	1,035	130				
Hake, fresh	11,717,682	134,709	25,270	230	6,684,326	170,637
Hake, salted	2,950	96			28,089	501
Halibut, fresh	139,947	21,884	265	37	4,358,389	766,774
Halibut, salted	800	64			1,530	166
Herring, fresh	47,930,152	447,160			9,035,024	100,352
Herring, salted					2,763,480	103,871
Hickory shad					3,895	157
Mackerel, fresh	2,243,037	99,178			20,441,737	1,152,423
Mackerel, salted	49,935	1,319			1,234,094	89,518
Menhaden	1,000	8			521,864	4,843
Pollock, fresh	2,676,772	38,349	4,075	62	5,338,483	174,279
Pollock, salted	99,506	2,111			10,660	195
Pollock, smoked	1,000	70				
Salmon	12,348	3,994			117	25
Scup					158,321	9,935
Sea bass					26,255	2,766
Shad	243,882	5,598			172,302	8,389
Sharks	21,605	535			25,156	965
Skates					40,979	795
Smelt	627,707	137,430	3,835	1,630	37,698	9,823
Squeteagues					1,646	284
Striped bass					1,023	260
Sturgeon	3,528	1,091			5,805	1,682
Sturgeon caviar	132	264				
Sturgeon roe					104	118
Suckers	153,050	15,327				
Swordfish	863,036	131,284			1,732,992	347,621
Tautog	125	13			131,214	11,520
Tilefish					38,000	3,040
Tomcod	74,050	868			2,191	74
Tuna or horse mackerel	68,405	1,724			122,913	5,604
Whiting	70,000	244			6,306,572	56,740
Other species	28,167	1,263			355,283	11,529
Lobster	5,513,002	1,772,165	125,600	40,000	1,679,601	557,437
Shrimp					750	600
Cockles and winkles					12,580	5,159
Crabs, hard	170,569	6,290	4,165	125	1,750,998	53,865
Squid	1,600	10			2,104,528	52,055
Clams, hard, public	960	80			1,217,768	358,389
Clams, hard, private					4,000	1,500
Clams, soft, public	3,576,340	228,251	36,000	3,600	2,381,750	280,668
Clams, soft, private					138,600	17,095
Clams, razor					22,800	3,040
Oysters, market, private					531,251	267,811
Oysters, seed, public					47,600	5,325
Oysters, seed, private					119,000	12,450
Scallops	95,730	25,687			559,392	192,987
Scallops, sea	200,514	54,989			138,600	48,650
Spawn	19,602	1,326			219,756	13,001
Livers	1,818	46			155,585	4,631
Tongues and sounds	555	27				
Alewife scales					3,000	1,500
Oil, liver	4,027	248				
Oil, sperm					99,227	6,410
Irish moss					115,000	5,175
Total	116,707,179	4,136,989	447,450	56,029	243,362,693	10,799,598

Fisheries of the New England States, 1924—Continued

PRODUCTS—Continued

Species	Rhode Island		Connecticut		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives, fresh	360, 737	$7, 803	98, 813	$2, 234	3, 659, 529	$41, 364
Alewives, salted			11, 662	275	315, 792	9, 063
Alewives, smoked	15, 000	225			49, 734	2, 802
Bluefish	3, 736	798	17, 241	4, 514	82, 153	21, 155
Bonito	4, 505	438			17, 772	1, 630
Butterfish	685, 450	45, 681	5, 650	442	1, 080, 902	89, 281
Carp			39, 333	5, 258	39, 333	5, 258
Cod, fresh	1, 356, 930	68, 296	538, 887	30, 972	84, 985, 564	2, 882, 680
Cod, salted					4, 232, 791	193, 285
Cusk, fresh					4, 167, 637	79, 586
Cusk, salted					59, 195	1, 407
Eels	168, 450	18, 656	112, 458	12, 406	858, 191	88, 115
Flounders	3, 099, 425	118, 915	4, 415, 927	197, 507	30, 854, 736	1, 339, 076
Grayfish	4, 100	47			21, 950	367
Haddock fresh	134, 200	4, 466	48, 950	2, 440	93, 468, 008	2, 655, 735
Haddock, salted					49, 783	1, 035
Haddock, smoked					1, 035	130
Hake, fresh	38, 000	660	3, 000	108	18, 468, 278	306, 344
Hake, salted					31, 039	597
Halibut, fresh					4, 498, 601	788, 695
Halibut, salted					2, 330	230
Herring, fresh	506, 900	10, 294	100	2	57, 472, 176	557, 808
Herring, salted					2, 763, 480	103, 871
Hickory, shad	15, 500	735	1, 900	83	21, 295	975
Mackerel, fresh	2, 380, 700	156, 933	303, 860	20, 067	25, 369, 334	1, 428, 601
Mackerel, salted					1, 284, 029	90, 837
Menhaden	1, 743, 025	17, 281	5, 270, 020	56, 438	7, 535, 909	78, 570
Pollock, fresh	116, 200	3, 740	48, 200	1, 941	8, 183, 730	218, 371
Pollock, salted					110, 166	2, 306
Pollock, smoked					1, 000	70
Salmon	90	18			12, 555	4, 037
Scup	1, 191, 625	59, 651	1, 750	176	1, 351, 696	69, 762
Sea bass	52, 200	4, 825	3, 150	469	81, 605	8, 060
Shad	10, 982	2, 795	88, 808	20, 855	515, 974	37, 637
Sharks	4, 000	74			50, 761	1, 574
Skates	13, 700	242	200	4	54, 879	1, 041
Smelt	7, 860	1, 592	11, 300	2, 410	688, 400	152, 885
Squeteagues	59, 254	8, 621	40, 835	5, 302	101, 735	14, 207
Striped bass	67, 960	12, 899	1, 545	396	70, 528	13, 555
Sturgeon	1, 640	324	290	79	11, 263	3, 176
Sturgeon caviar					132	264
Sturgeon roe	75	94			179	212
Suckers			119, 674	8, 024	272, 724	23, 351
Swordfish	206, 041	34, 925	80, 145	13, 896	2, 882, 214	527, 726
Tautog	191, 300	16, 033	72, 636	6, 234	395, 275	33, 800
Tilefish			200, 130	14, 170	238, 130	17, 210
Tomcod	4, 250	141	190	7	80, 681	1, 090
Tuna or horse mackerel	40, 900	4, 803			232, 218	12, 131
Whiting	1, 744, 200	27, 664	2, 000	40	8, 122, 772	84, 688
Other species	230, 520	6, 878	11, 441	1, 471	625, 411	21, 141
Lobster	1, 696, 346	462, 000	701, 647	240, 809	9, 716, 196	3, 072, 411
Shrimp	4, 000	2, 400			4, 750	3, 000
Cockles and winkles	3, 500	700			16, 080	5, 859
Crabs, hard	50, 000	1, 000	440	28	1, 976, 172	61, 308
Crabs, sand			10, 000	250	10, 000	250
Squid	952, 700	23, 322	16, 630	484	3, 075, 458	75, 871
Clams, hard, public	432, 400	134, 500	22, 096	10, 005	1, 673, 224	502, 974
Clams, hard, private			1, 536	768	5, 536	2, 268
Clams, soft, public	82, 400	15, 480	44, 350	12, 155	6, 120, 840	540, 154
Clams, soft, private					138, 600	17, 095
Clams, razor					22, 800	3, 040
Oysters, market, public	3, 500	750	18, 410	3, 865	21, 910	4, 615
Oysters, market, private	2, 580, 186	457, 614	4, 140, 416	683, 034	7, 251, 853	1, 408, 459
Oysters, seed, public			383, 950	55, 933	431, 550	61, 258
Oysters, seed, private			3, 477, 516	583, 224	3, 596, 516	595, 674
Scallops	270, 840	84, 545	2, 430	683	928, 392	303, 902
Scallops, sea					339, 114	103, 639
Spawn					239, 358	14, 327
Livers					157, 403	4, 677
Tongues and sounds					555	27
Alewife scales					3, 000	1, 500
Oil, liver					4, 027	248
Oil, sperm					99, 227	6, 410
Irish, moss					115, 000	5, 175
Oyster shells			5, 400, 000	7, 200	5, 400, 000	7, 200
Total	20, 535, 327	1, 818, 858	25, 769, 516	2, 006, 658	406, 822, 165	18, 818, 132

Certain of the foregoing fishery products shown in bushels, number, and gallons

Product	Maine		New Hampshire		Massachusetts	
	Quantity	*Value*	*Quantity*	*Value*	*Quantity*	*Value*
Clams:						
Hard (quahog)—						
Public, bushels	120	$80			152,221	$358,389
Private, do					500	1,500
Soft—						
Public, do	357,634	228,251	3,600	$3,600	238,175	280,668
Private, do					13,860	17,095
Razor, do					2,280	3,040
Oysters:						
Market, private, do					75,893	267,811
Seed—						
Public, do					6,800	5,325
Private, do					17,000	12,450
Scallops, do	15,955	25,687			93,232	192,987
Scallops, sea, do	33,419	54,989			23,100	48,650
Cockles and winkles, do					1,258	5,159
Crabs, hard, number	511,707	6,290	12,495	125	5,252,994	53,865
Oil:						
Liver, gallons	520	248				
Sperm, do					12,820	6,410

Product	Rhode Island		Connecticut		Total	
	Quantity	*Value*	*Quantity*	*Value*	*Quantity*	*Value*
Clams:						
Hard (quahog)—						
Public, bushels	54,050	$134,500	2,762	$10,005	209,153	$502,974
Private, do			192	768	692	2,268
Soft—						
Public, do	8,240	15,480	4,435	12,155	612,084	540,154
Private, do					13,860	17,095
Razor, do					2,280	3,040
Oysters:						
Market—						
Public, do	500	750	2,630	3,865	3,130	4,615
Private, do	368,598	457,614	591,488	683,034	1,035,979	1,408,459
Seed—						
Public, do			54,850	55,933	61,650	61,258
Private, do			496,788	583,224	513,788	595,674
Scallops, do	45,140	84,545	405	683	154,732	303,902
Scallops, sea, do					56,519	103,639
Cockles and winkles, do	350	700			1,608	5,859
Crabs:						
Hard, number	150,000	1,000	1,320	28	5,928,516	61,308
Sand, do			30,000	250	30,000	250
Oil:						
Liver, gallons					520	248
Sperm, do					12,820	6,410
Oyster shells, bushels			90,000	7,200	90,000	7,200

Extent of the fisheries of the New England States, various years, 1880 to 1924[1]

Year	Maine	New Hampshire	Massachusetts	Rhode Island	Connecticut	Total
PERSONS ENGAGED						
1880	11,071	414	20,117	2,310	3,131	37,043
1887	15,323	346	17,053	1,635	3,024	37,381
1888	15,171	362	17,037	1,703	3,037	37,310
1889	14,129	365	17,238	1,757	3,047	36,536
1898	16,954	154	14,363	1,687	2,473	35,631
1902	19,832	161	14,300	2,117	2,840	39,250
1905	15,881	145	15,694	2,212	3,407	37,339
1908	6,861	79	11,577	1,493	2,147	22,157
1919	14,386	100	12,346	1,646	2,289	30,767
1924	11,942	145	9,275	1,469	1,682	24,513
INVESTMENT						
1880	$3,341,344	$209,465	$14,334,450	$596,678	$1,421,020	$19,902,957
1887	3,179,233	106,110	13,205,050	992,761	2,897,687	20,380,841
1888	3,023,921	107,144	13,110,765	1,022,876	2,869,314	20,134,020
1889	2,889,893	112,660	13,245,229	1,020,178	2,826,834	20,094,794
1898	4,013,053	52,648	13,372,902	957,142	1,241,291	19,637,036
1902	6,939,503	42,002	10,811,594	1,014,280	1,201,055	20,008,434
1905	8,972,049	47,050	10,810,442	1,065,426	1,635,753	22,530,720
1908	2,411,000	23,000	5,750,000	1,504,000	2,281,000	11,969,000
1919	17,544,969	45,530	19,111,269	2,249,488	1,645,793	40,597,049
1924	9,406,334	68,315	15,362,016	1,666,587	2,058,572	28,561,824
PRODUCTS						
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
1887	131,379,591	4,254,727	299,544,343	45,284,872	39,750,008	520,213,541
1888	132,929,594	3,843,479	302,045,686	91,687,487	42,401,612	572,907,858
1889	129,559,864	4,354,568	299,217,669	127,365,475	92,672,464	653,170,040
1898	123,404,561	3,020,715	202,257,817	32,854,396	31,920,417	393,457,906
1902	242,390,371	1,593,013	230,645,950	21,613,964	37,832,149	534,075,447
1905	124,723,786	1,036,452	255,654,475	23,896,243	74,972,648	480,283,604
1908	173,843,000	677,000	244,313,000	44,254,000	66,942,000	530,029,000
1919	147,956,369	528,730	246,951,241	48,250,883	23,652,647	470,995,169
1924	116,707,178	447,450	243,362,693	20,535,327	25,769,516	406,822,165
	Value	*Value*	*Value*	*Value*	*Value*	*Value*
1880	$2,742,571	$170,634	$7,959,760	$696,814	$933,242	$12,503,021
1887	2,364,906	99,460	6,464,396	683,495	300,746	9,913,003
1888	2,292,043	90,044	6,355,495	825,092	297,337	9,860,011
1889	2,111,206	88,511	5,858,274	935,144	1,557,506	10,550,641
1898	2,654,919	48,987	4,463,727	955,058	1,559,599	9,682,290
1902	2,918,772	50,003	6,482,427	1,155,701	1,799,381	12,406,284
1905	2,386,406	51,944	7,025,249	1,546,658	3,173,948	14,184,205
1908	3,257,000	53,000	7,095,000	1,752,000	2,982,000	15,139,000
1919	3,889,035	92,660	10,859,746	3,296,678	1,700,638	19,887,406
1924	4,136,989	56,029	10,799,598	1,818,858	2,006,658	18,818,132

[1] The statistics for 1908 are from data published by the Bureau of the Census.

NOTE.—The statistics in this table include the persons engaged and capital invested in both the fisheries and fishery industries.

Products, in pounds, of certain fisheries of the New England States, various years, 1889 to 1924

Year	Alewives	Cod	Flounders	Haddock	Hake	Halibut	Herring
1889	7,882,682	97,145,645	2,950,978	43,473,627	14,816,306	10,740,843	36,316,259
1898	6,985,948	89,207,975	4,109,494	45,676,155	37,184,193	10,828,187	64,587,461
1902	8,437,446	88,254,949	4,808,746	47,077,315	33,182,559	12,365,705	191,739,467
1905	8,743,284	75,065,224	5,761,473	76,617,156	35,470,667	3,017,776	83,390,554
1908	7,581,000	95,284,000	9,753,000	59,544,000	34,121,300	4,353,500	121,700,000
1919	3,782,289	84,917,535	15,541,047	89,405,609	20,222,267	1,960,030	97,636,395
1924	4,025,055	89,218,355	30,854,736	93,518,826	18,499,317	4,500,931	60,235,656

Year	Mackerel	Pollock	Shad	Swordfish	Whiting	Lobsters	Clams, hard	Clams, soft
1889	8,361,408	8,442,397	1,334,714	1,230,339	126,089	30,449,603	544,200	11,542,272
1898	8,795,084	9,444,887	1,415,649	1,617,331	41,050	14,661,808	594,232	11,296,901
1902	20,358,982	17,744,127	1,380,812	1,689,740	2,513,470	14,756,495	1,223,200	8,345,470
1905	15,981,034	28,949,359	1,260,904	3,296,369	4,812,840	11,524,499	1,568,264	6,375,850
1908	11,492,000	29,244,300	1,285,500	2,703,000	713,000	14,734,000	1,381,000	7,294,000
1919	15,785,012	25,009,639	939,995	1,325,980	16,195,637	10,666,707	1,082,152	4,992,874
1924	26,653,363	8,294,866	515,974	2,882,214	8,122,772	9,716,196	1,678,760	6,259,440

WHOLESALE FISHERY TRADE

The wholesale fishery trade in the New England States in 1924 was conducted in 200 establishments, valued at $4,778,356, carrying cash capital of $1,310,950 and employing 1,922 persons, to whom $2,157,537 were paid in salaries and wages. The State of Massachusetts was most important in the wholesale fish trade, having 103 firms. Maine was next in importance with 54 firms, including two engaged in making pearl essence.. Rhode Island was third with 25 firms. Connecticut was fourth with 17 firms, and New Hampshire was last with only one firm.

Wholesale fishery trade of the New England States, 1924

Items	Maine and New Hampshire		Massachusetts		Rhode Island		Connecticut		Total	
	Number	*Value*	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*
Establishments	[1] 55	$642,398	103	$3,552,295	25	$284,563	17	$299,100	200	$4,778,356
Persons engaged	271		1,077		217		357		1,922	
Wages paid		188,620		1,566,654		173,604		228,659		2,157,537
Cash capital		163,850		1,010,900		60,700		75,500		1,310,950

[1] Includes one fresh-fish establishment in New Hampshire and two firms in Maine engaged in making pearl essence.

FISH-CANNING AND BY-PRODUCTS INDUSTRIES

The fish-canning industry of the New England States is located chiefly in Maine and consists mostly in canning sardines. Sardines are canned to a limited extent in Massachusetts also, and there is considerable canning of other products in Maine, Massachusetts, and Rhode Island. Fishery by-products are prepared in all of the States except New Hampshire. The number of plants engaged in these industries in 1924 was 82, having a value of $4,379,662. There were 5,539 persons engaged in these plants, who received wages during the year amounting to $2,316,881, and the cash or working capital employed amounted to $489,500. Of these establishments, 62 were engaged in canning fishery products and 20 in the preparation of fishery by-products, such as fish scrap, fish meal, oil, glue, poultry grit, isinglass, and lime. Sardines were canned at 28 plants in Maine and 1 in Massachusetts. Soft clams were canned at 19 plants in Maine and 2 in Massachusetts, and hard clams at 1 in Rhode Island. There was one menhaden factory in Connecticut. The remaining plants were engaged in canning various products and in the preparation of by-products.

The output included 2,442,284 cases of canned products, valued at $9,255,939, and by-products of various kinds to the value of $1,041,446. The total value of the output amounted to $10,297,385. The canned products included sardines, 1,840,421 cases, valued at $7,269,462; canned clams, 90,609 cases, valued at $478,129; clam chowder, 118,056 cases, valued at $410,165; clam juice and bouillon, 5,747 cases, valued at $9,399; and miscellaneous canned products, 387,452 cases, valued at $1,088,784.

The by-products included fish scrap, 2,930,000 pounds, valued at $64,304; fish meal, 6,345,500 pounds, valued at $146,307; fish oil, 282,044 gallons, valued at $137,031; fish glue, 600,200 gallons, valued at $573,922; poultry grit, 4,924,000 pounds, valued at $33,480; and other products, including isinglass, green fish scrap, and lime, to the value of $86,402.

The extent of the fish canning and by-products industries of the New England States in 1924 is given in detail in the following table:

Fish canning and by-products industries of the New England States in 1924

Item	Number	Value
Plants	[4] 82	$4,379,662
Persons engaged	5,539	
Wages paid		2,316,881
Cash capital		489,500
CANNED PRODUCTS		
Sardines:		
In olive oil: Quarters (100 cans)—cases	39,012	247,027
In cottonseed oil: Quarters (100 cans)—cases	[1] 1,481,431	5,729,852
In mustard:		
Quarters (100 cans)—cases	115,291	486,924
Three-quarters (48 cans)—cases	[2] 184,905	717,470
In tomato sauce: Quarters (100 cans)—cases	19,782	88,189
Clams:		
5-ounce (4 dozen)—cases	[3] 62,848	309,349
6-ounce (2 dozen)—do	5,410	17,474
8-ounce (4 dozen)—do	[4] 16,029	121,854
10-ounce (2 dozen)—do	6,321	29,452
Clam chowder:		
Nos. 1 and 1½ (2 dozen)—cases	67,264	199,669
No. 2 (2 dozen)—do	2,538	7,502
No. 3 (2 dozen)—do	47,029	197,468
No. 10 (½ dozen)—do	1,225	5,526
Clam juice and bouillon:		
5-ounce (4 dozen)—cases	265	$503
10-ounce (2 dozen)—do	[5] 5,482	8,896
Miscellaneous products (various sizes)—cases	[6] 387,452	1,088,784
Total	2,442,284	9,255,939
BY-PRODUCTS		
Scrap—pounds	2,930,000	64,304
Fish meal—do	6,345,500	146,307
Oil:		
Cod and cod-liver, crude—gallons	106,805	66,079
Herring—do	75,587	24,291
Miscellaneous—do	99,652	46,661
Glue—do	600,200	573,922
Poultry grit—pounds	4,924,000	33,480
Miscellaneous by-products		86,402
Total		1,041,446
Grand total		10,297,385

[1] Includes a few cases of ¾-pound cans, 50 cans to the case, converted to a basis of ¼-pound cans, 100 to the case.
[2] Includes a few cases of 50 cans each, converted to a basis of 48 cans to the case.
[3] Includes a few cases of 4-ounce cans converted to a basis of 5-ounce cans.
[4] Includes the pack of 8 and 8½ ounce cans, 2 dozen to the case, converted to a basis of 8-ounce cans, 4 dozen to the case.
[5] Includes a few cases of No. 10 cans converted to a basis of 10-ounce cans; also a few cases of 14-ounce cans, 4 dozen to the case, converted to a basis of 10-ounce cans, 2 dozen to the case.
[6] Includes canned fish flakes, finnan haddie, codfish, boneless herring, haddock chowder, mackerel, deep-sea roe, fiskeboller, and caviarelle.

SALT AND SMOKED FISH INDUSTRIES

The salt and smoked fish industries of the New England States are carried on chiefly in Maine and Massachusetts. In the salted-fish industry in 1924, there were 64 plants, valued at $2,222,313, and the cash or working capital amounted to $279,700. There were 985 persons engaged, who received $874,713 in wages. The total quantity of salted fish prepared was 31,481,569 pounds, valued at $2,979,542. The output in Maine amounted to 13,002,679 pounds, valued at $825,403, and in Massachusetts to 18,478,890 pounds, valued at $2,154,139. The species salted in largest quantities included cod, 16,881,320 pounds, valued at $2,120,046; haddock, 4,132,956 pounds, valued at $283,587; hake, 4,747,176 pounds, valued at $192,054; mackerel, 2,129,393 pounds, valued at $192,045; pollock, 1,442,168 pounds, valued at $93,581; and herring, 770,610 pounds, valued at $37,581. The salted fishery products also included considerable quantities of alewives, cusk, shad, and cod cheeks, tongues, and sounds.

In the smoked-fish industry there were 64 plants, valued at $513,235, with cash or working capital amounting to $164,950. There were 613 persons engaged, and the wages paid during the year amounted to $326,404. The smoked-fish products aggregated 10,356,567 pounds, valued at $1,014,189. The output in Maine was 3,742,862

pounds, valued at $468,380, and in Massachusetts 6,613,705 pounds, valued at $545,809. The greater part of these products consisted of smoked herring, amounting to 7,431,324 pounds, valued at $659,399, of which 2,510,326 pounds, valued at $329,089, were prepared in Maine and 4,920,998 pounds, valued at $330,310, in Massachusetts. The remainder of the smoked fish included alewives, finnan haddie, halibut, and other species.

A number of the plants engaged in salting fish also smoked fish incidentally, and a number of those engaged in smoking did some salting. The salted and smoked products prepared by these firms are included in the statistics. The statistics also include the salted and smoked fish prepared by firms in the canning industry.

The extent of the salted and smoked fish industries in these States in 1924, exclusive of salted fish prepared by the fishermen and included in the statistics of the catch taken in the fisheries, is given in the following tables:

Salt-fish industry of Maine and Massachusetts in 1924

Item	Maine		Massachusetts		Total	
	Number	*Value*	*Number*	*Value*	*Number*	*Value*
Plants	37	$1,279,598	27	$942,715	64	$2,222,313
Persons engaged	451		534		985	
Wages paid		338,288		536,425		874,713
Cash capital		94,400		185,300		279,700
PRODUCTS						
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives	603,038	$13,408	53,000	$5,300	656,038	$18,708
Cod	5,675,886	454,055	10,591,395	1,543,368	16,267,281	1,997,423
Cod, boneless	611,239	122,248	2,800	375	614,039	122,623
Cusk	161,976	5,403	478,556	30,020	640,532	35,423
Cusk, boneless	1,079	162			1,079	162
Haddock	1,143,750	46,597	2,983,806	236,288	4,127,556	282,885
Haddock, boneless	5,400	702			5,400	702
Hake	4,074,213	153,606	672,963	38,448	4,747,176	192,054
Herring	32,330	755	738,280	36,826	770,610	37,581
Mackerel			2,129,393	192,045	2,129,393	192,045
Pollock	682,500	27,614	759,668	65,967	1,442,168	93,581
Shad	5,000	350			5,000	350
Cod cheeks, tongues, and sounds	6,268	503	69,029	5,502	75,297	6,005
Total	13,002,679	825,403	18,478,890	2,154,139	31,481,569	2,979,542

Smoked-fish industry of Maine and Massachusetts in 1924

Item	Maine		Massachusetts		Total	
	Number	*Value*	*Number*	*Value*	*Number*	*Value*
Plants	47	$168,250	17	$344,985	64	$513,235
Persons engaged	432		181		613	
Wages paid		93,439		232,965		326,404
Cash capital		42,450		122,500		164,950
PRODUCTS						
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives	119,460	$7,900			119,460	$7,900
Finnan haddie	1,113,076	131,391	1,252,241	$109,036	2,365,317	240,427
Halibut			39,966	7,939	39,966	7,939
Herring:						
Bloaters	384,005	40,387	1,669,998	139,700	2,054,003	180,087
Lengthwise	49,645	4,172			49,645	4,172
Medium scale	163,795	14,690			163,795	14,690
Boneless	1,782,790	257,417			1,782,790	257,417
Plain or kippered			3,251,000	190,610	3,251,000	190,610
Whole	58,091	10,023			58,091	10,023
Russian sardines	72,000	2,400			72,000	2,400
Other fish			400,500	98,524	400,500	98,524
Total	3,742,862	468,380	6,613,705	545,809	10,356,567	1,014,189

MAINE

Among the New England States in 1924 Maine was second only to Massachusetts in the importance of her fisheries. There were 6,252 persons engaged in the fisheries, of whom 739 were on fishing vessels, 226 on transporting vessels, 4,988 in the shore and boat fisheries, and 299 were employed as shoresmen. The total investment amounted to $3,792,875, which included 230 vessels valued, together with their outfits, at $1,746,472; 2,684 motor boats, valued at $951,205; 1,989 sail and rowboats, valued at $52,527; gear to the value of $881,835, and shore and accessory property to the value of $160,836. The total yield of the fisheries amounted to 116,707,179 pounds, valued at $4,136,989. Based on the value of their yield, the most important species were lobsters, 51,513,002 pounds, valued at $1,772,165; cod, 21,409,737 pounds, valued at $574,804; herring, 47,930,152 pounds, valued at $447,160; haddock, 15,508,289 pounds, valued at $357,352; clams, 3,577,300 pounds, valued at $228,331; smelt, 627,707 pounds, valued at $137,430; and swordfish, 863,036 pounds, valued at $131,284.

Fisheries.—Of the total yield the vessel fisheries produced 37,966,520 pounds, valued at $956,045. The most valuable catch in this fishery was made with lines, amounting to 13,281,355 pounds, valued at $326,585, of which cod and haddock were the most important items. Otter trawls were next, with 10,879,185 pounds, valued at $283,903. Harpoons took 863,036 pounds of swordfish, valued at $131,284. Purse seines, gill nets, haul seines, lobster pots, set nets, and scallop dredges took the remainder of the yield of the vessel fisheries.

The shore and boat fisheries landed 78,740,659 pounds of fishery products, valued at $3,180,944. Lobster pots produced the most valuable yield, amounting to 5,623,810 pounds, valued at $1,759,990. Lines were next, with a yield of 24,319,108 pounds, valued at $476,916, consisting largely of cod, haddock, hake, and smelts. Pound nets, trap nets, weirs, followed with a catch of 30,711,853 pounds, valued at $339,366, of which herring were by far the most important item. Clam hoes yielded 3,577,300 pounds, valued at $228,331. Gill nets, scallop dredges and drags, set nets, bag and pocket nets, haul seines, purse seines, fyke nets, otter trawls, dip nets, eel pots and traps, sluiceways and traps, harpoons, spears and cunner traps, named in order of importance, made up the remainder of the yield of the shore and boat fisheries.

Wholesale trade and industries.—The wholesale fishery trade of Maine, including one firm in New Hampshire and two in Maine engaged in the pearl-essence industry, was carried on in 55 establishments, valued at $642,398, carrying cash capital of $163,850 and employing 271 persons, to whom $188,620 were paid in salaries and wages. Canning, salting, smoking and the manufacture of by-products were carried on in 148 establishments, which were valued at $4,444,761, carried a cash capital of $397,350, employed 5,430 persons, to whom $1,619,115 were paid in salaries and wages, and manufactured $9,668,232 worth of products.

The following tables and summary statements present the detailed statistics of the fisheries of Maine in 1924.[12]

Yield of the vessel fisheries of Maine in 1924, by apparatus and species

Species	Otter trawls		Purse seines		Gill nets		Lines	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives			2,600	$33				
Butterfish			318	43				
Cod, fresh	4,520,835	$131,631	1,910	67	1,245,754	$37,014	4,096,585	$115,890
Cod, salted	246,811	11,779					747,845	31,831
Cusk, fresh	180	3	105	2	10,431	171	1,024,940	18,290
Cusk, salted							1,055	26
Flounders	79,930	3,304			1,055	13	1,052	18
Haddock, fresh	5,366,937	122,591	105	3	307,204	7,398	4,456,589	102,667
Haddock, salted	45,010	900						
Hake, fresh	19,364	368	55	1	69,059	1,063	2,515,292	41,214
Hake, salted							590	12
Halibut, fresh	20,560	2,956					50,672	7,673
Halibut, salted							800	64
Herring	92,210	842	2,971,863	38,757				
Mackerel, fresh	9,222	430	550,875	28,381	164,141	13,829		
Mackerel, salted			49,935	1,319				
Pollock, fresh	449,038	8,540	348,568	3,558	163,383	3,050	364,528	7,766
Pollock, salted	26,208	446					310	5
Rosefish					40	1	537	8
Salmon					5	1		
Shad			127,186	2,488	39	5		
Sharks			90	2	2,015	39	400	6
Sturgeon					161	20		
Wolf fish					97	2	5,906	114
Scallops	54	17						
Tongues	90	4						
Spawn	2,736	92			125	2	13,054	965
Livers					137	2	1,200	36
Total	10,879,185	283,903	4,053,610	74,654	1,963,646	62,610	13,281,355	326,585

Species	Haul seines		Set nets		Harpoons		Lobster pots and scallop dredges	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Cod, fresh	274	$9						
Flounders	100	2						
Herring	5,176,431	31,171	1,628,702	$14,929				
Shad	328	25						
Smelt	2,308	360	710	142				
Sturgeon	102	15						
Swordfish					863,036	$131,284		
Wolf fish	50	1						
Lobsters							[1] 59,761	$18,465
Scallops							[2] 56,922	11,890
Total	5,179,593	31,583	1,629,412	15,071	863,036	131,284	116,683	30,355

[1] Taken by lobster pots.
[2] Taken by scallop dredges.
[12] For statistics on persons engaged, vessels, boats, gear, and investment in the fisheries refer to page 296.

Yield of the shore and boat fisheries of Maine in 1924, by apparatus and species

Species	Pound nets, trap nets, and weirs		Haul seines		Lines		Gill nets	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives, fresh	267,420	$3,236					500	$25
Alewives, salted	7,200	126						
Alewives, smoked	12,337	794					15,137	1,420
Butterfish	11,555	1,090						
Cod, fresh					8,078,494	$177,881	2,431,655	66,657
Cod, salted					39,074	2,025		
Cusk					519,216	8,712	12,157	380
Eels	29,400	4,410			3,500	550		
Flounders					53,625	2,174		
Haddock, fresh					5,081,221	117,536	245,738	6,000
Haddock, salted					4,450	127		
Haddock, smoked					1,035	130		
Hake, fresh					8,943,612	88,933	132,800	2,380
Hake, salted					2,360	84		
Halibut					68,715	11,255		
Herring	29,137,436	287,184	19,000	$175			3,000	150
Mackerel	1,147,280	36,594	800	50			127,664	9,609
Menhaden			1,000	8				
Pickerel					4,500	675		
Pollock, fresh	2,960	37			1,225,095	12,573	123,200	2,825
Pollock, salted					72,988	1,660		
Pollock, smoked					1,000	70		
Rosefish					2,800	43		
Salmon	11,490	3,701					703	240
Shad	1,455	175					8,654	1,202
Sharks	300	7			1,600	38	17,200	443
Smelt	8,465	1,679	199,166	32,747	197,533	51,697	28,155	7,715
Sturgeon							3,265	1,056
Sturgeon caviar							132	264
Tautog	125	13						
Tomcod			5,150	168				
Tuna or "horse mackerel"	310	16						
Whiting	70,000	244						
Wolf fish	2,520	50			9,630	207		
Squid	1,600	10						
Sounds					465	23		
Spawn					3,687	267		
Livers					481	8		
Oil, livers					4,027	248		
Total	30,711,853	339,366	225,116	33,148	24,319,108	476,916	3,149,960	100,366

Species	Purse seines		Fyke nets		Set nets		Dip nets	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives, fresh	72,540	$920					710,015	$4,405
Alewives, smoked							7,260	363
Cod					500	$20		
Eels			1,295	$107				
Herring	1,284,074	13,592			7,617,436	60,360		
Mackerel	243,055	10,285						
Shad	106,220	1,703						
Smelt			22,650	3,890			6,000	1,500
Suckers			153,050	15,327				
Tomcod			60,000	300			8,900	400
Yellow perch			975	92				
Total	1,705,889	26,500	237,970	19,716	7,617,936	60,380	732,175	6,668

Species	Lobster pots, eel pots, and traps		Sluiceways and traps		Other trawls		Bag nets and packet nets	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Eels	[1] 76,106	$6,422	34,100	$4,680				
Flounders					207,541	$8,112		
Hake					37,500	750		
Salmon							150	$52
Smelt							162,720	37,700
Lobsters	[2] 5,453,241	1,753,700						
Crabs, hard	[2] 170,569	6,290						
Total	5,699,916	1,766,412	34,100	4,680	245,041	8,862	162,870	37,752

[1] Taken by eel pots and traps.

[2] Taken by lobster pots.

Yield of the shore and boat fisheries of Maine in 1924, by apparatus and species—Continued

Species	Harpoons and spears		Cunner traps		Scallop dredges and drags		Clam hoes	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Cunner			1,112	$70				
Eels	[3] 12,950	$1,300						
Tuna or "horse mackerel"	[4] 68,095	1,708						
Clams, hard							960	$80
Clams, soft							3,576,340	228,251
Scallops					38,754	$13,780		
Scallops, sea					200,514	54,969		
Total	81,045	3,008	1,112	70	239,268	68,769	3,577,300	228,331

[3] Taken by spears. [4] Taken by harpoons.

Summary of the yield

Species	Shore fisheries		Vessel fisheries		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives, fresh	1,050,475	$8,586	2,600	$33	1,053,075	$8,619
Alewives, salted	7,200	126			7,200	126
Alewives, smoked	34,734	2,577			34,734	2,577
Butterfish	11,555	1,090	318	43	11,873	1,133
Cod, fresh	10,510,649	244,558	9,865,358	284,611	20,376,007	529,169
Cod, salted	39,074	2,025	994,656	43,610	1,033,730	45,635
Cunners	1,112	70			1,112	70
Cusk, fresh	531,373	9,092	1,035,656	18,466	1,567,029	27,558
Cusk, salted			1,055	26	1,055	26
Eels	157,351	17,469			157,351	17,469
Flounders	261,166	10,286	82,137	3,337	343,303	13,623
Haddock, fresh	5,326,959	123,536	10,130,835	232,659	15,457,794	356,195
Haddock, salted	4,450	127	45,010	900	49,460	1,027
Haddock, smoked	1,035	130			1,035	130
Hake, fresh	9,113,912	92,063	2,603,770	42,646	11,717,682	134,709
Hake, salted	2,360	84	590	12	2,950	96
Halibut, fresh	68,715	11,255	71,232	10,629	139,947	21,884
Halibut, salted			800	64	800	64
Herring	38,060,946	361,461	9,869,206	85,699	47,930,152	447,160
Mackerel, fresh	1,518,799	56,538	724,238	42,640	2,243,037	99,178
Mackerel, salted			49,935	1,319	49,935	1,319
Menhaden	1,000	8			1,000	8
Pickerel	4,500	675			4,500	675
Pollock, fresh	1,351,255	15,435	1,325,517	22,914	2,676,772	38,349
Pollock, salted	72,988	1,660	26,518	451	99,506	2,111
Pollock, smoked	1,000	70			1,000	70
Rosefish	2,800	43	577	9	3,377	52
Salmon	12,343	3,993	5	1	12,348	3,994
Shad	116,329	3,080	127,553	2,518	243,882	5,598
Sharks	19,100	488	2,505	47	21,605	535
Smelt	624,689	136,928	3,018	502	627,707	137,430
Sturgeon	3,265	1,056	263	35	3,528	1,091
Sturgeon caviar	132	264			132	264
Suckers	153,050	15,327			153,050	15,327
Swordfish			863,036	131,284	863,036	131,284
Tautog	125	13			125	13
Tomcod	74,050	868			74,050	868
Tuna or horse mackerel	68,405	1,724			68,405	1,724
Whiting	70,000	244			70,000	244
Wolf fish	12,150	257	6,053	117	18,203	374
Yellow perch	975	92			975	92
Squid	1,600	10			1,600	10
Lobsters	5,453,241	1,753,700	59,761	18,465	5,513,002	1,772,165
Crabs, hard	170,569	6,290			170,569	6,290
Clams, hard	960	80			960	80
Clams, soft	3,576,340	228,251			3,576,340	228,251
Scallops	38,754	13,780	56,976	11,907	95,730	25,687
Scallops, sea	200,514	54,989			200,514	54,989
Tongues			90	4	90	4
Sounds	465	23			465	23
Spawn	3,687	267	15,915	1,059	19,602	1,326
Livers	481	8	1,337	38	1,818	46
Oil, liver	4,027	248			4,027	248
Total	78,740,659	3,180,944	37,966,520	956,045	116,707,179	4,136,989

Summary by counties

County	Persons engaged	Investment	Products	
	Number	*Dollars*	*Pounds*	*Value*
Cumberland	914	633,022	22,823,252	$829,319
Hancock	1,499	523,221	22,813,838	839,460
Kennebec	43	5,530	128,145	15,048
Knox	950	1,177,706	23,853,314	1,006,739
Lincoln	677	291,151	11,265,266	378,711
Penobscot	11	2,340	26,390	6,237
Sagadahoc	395	53,758	1,903,874	115,732
Waldo	69	45,372	4,141,238	55,482
Washington	1,376	862,002	23,403,653	585,246
York	318	198,773	6,348,209	305,015
Total	6,252	3,792,875	116,707,179	4,136,989

NEW HAMPSHIRE

New Hampshire, with only one coastal county, was the least important of the New England States with respect to her fisheries. Exclusive of the wholesale trade, there were 134 persons engaged, of whom 2 were on fishing vessels, 4 on transporting vessels, 93 in the shore or boat fisheries, and 35 were employed as shoresmen. The total investment in the fisheries amounted to $33,415, which included 3 vessels valued, together with their outfits, at $12,375; 39 motor boats, valued at $10,000; 33 sail and rowboats, valued at $1,100; gear to the value of $6,040; and shore and accessory property to the value of $3,900. The total yield of the fisheries amounted to 447,450 pounds, valued at $56,029. Lobsters contributed over 70 per cent of the value of this yield. Next in importance were haddock, cod, and soft clams.

Fisheries.—The only gear used in the vessel fisheries was the trawl line, the total yield of which amounted to 52,535 pounds, valued at $1,610. The most important item in this yield was haddock. The shore and boat fisheries yielded 394,915 pounds of fishery products, valued at $54,419. Lobster pots were the most important gear, yielding 129,765 pounds of lobsters and crabs, valued at $40,125. Trawl lines were next, with 211,115 pounds, valued at $7,954, of which haddock and cod were the most important items. Hand lines, eel pots, dip nets, spears, and hoes took the remainder of the yield of this fishery.

Wholesale trade and industries.—The wholesale fishery trade of New Hampshire was carried on by two firms, and the detailed statistics are included with those of the wholesale trade of Maine.

The following tables and summary statements present the detailed statistics of the fisheries of New Hampshire in 1924.[13]

Yield of the shore and boat fisheries of New Hampshire in 1924, by apparatus and species

Apparatus and species	Pounds	Value	Apparatus and species	Pounds	Value
Hand lines:			Lobster pots:		
Cod	7,500	$375	Lobsters	125,600	$40,000
Haddock	500	25	Crabs, hard	4,165	125
Smelt	3,000	1,200	Total	129,765	40,125
Total	11,000	1,600			
Trawl lines:			Eel pots: Eels	1,200	150
Cod	86,660	3,410	Dip nets: Smelt	835	430
Cusk	600	10	Spears: Eels	5,000	560
Haddock	100,180	4,250	Hoes: Clams, soft	36,000	3,600
Hake	19,935	190			
Halibut	265	37	Grand total	394,915	54,419
Pollock	3,475	57			
Total	211,115	7,954			

[13] For statistics on persons engaged, vessels, boats, gear, and investment in the fisheries refer to page 296.

Summary of the yield

Products	Vessel fisheries		Shore fisheries		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Cod	3,600	$75	94,160	$3,785	97,760	$3,860
Cusk			600	10	600	10
Eels			6,200	710	6,200	710
Haddock	43,000	1,490	100,680	4,275	143,680	5,765
Hake	5,335	40	19,935	190	25,270	230
Halibut			265	37	265	37
Pollock	600	5	3,475	57	4,075	62
Smelt			3,835	1,630	3,835	1,630
Crabs, hard			4,165	125	4,165	125
Lobsters			125,600	40,000	125,600	40,000
Clams, soft			36,000	3,600	36,000	3,600
Total	52,535	1,610	394,915	54,419	447,450	56,029

MASSACHUSETTS

In 1924, as in previous years, Massachusetts fisheries were the most important among the New England States. There were 7,123 persons engaged in the fisheries, of whom 3,087 were employed on fishing vessels, 29 on transporting vessels, 3,643 in the shore or boat fisheries, and 364 as shoresmen. The total investment amounted to $8,428,998, which included 333 fishing and transporting vessels, valued, together with their outfits, at $6,433,568; 1,608 motor boats, valued at $770,640; 1,780 sail and row boats, valued at $60,730; fishing gear and apparatus to the value of $848,702; and shore and accessory property to the value of $315,358. Some of the most important species, arranged in order of value of their yields, were cod, 65,815,041 pounds, valued at $2,398,033; haddock, 77,683,707 pounds, valued at $2,286,877; mackerel, 21,675,831 pounds, valued at $1,241,941; flounders, 22,996,081 pounds, valued at $1,009,031; halibut, 4,359,919 pounds, valued at $766,940; clams, 3,764,918 pounds, valued at $660,692; lobsters, 1,679,601 pounds, valued at $557,437; swordfish, 1,732,922 pounds, valued at $347,621; oysters, 697,851 pounds, valued at. $285,586; scallops, 697,992 pounds, valued at $241,637; and herring, 11,798,504 pounds, valued at $204,223. Other important species were pollock, hake, whiting, crabs, and squid.

Fisheries.—The vessel fisheries yielded a total of 188,766,122 pounds of fishery products, valued at $7,746,831. In this fishery, lines were most important, yielding 100,417,198 pounds of cod, haddock, halibut, and other fishes valued at $3,800,819. Otter trawls were next, with 61,124,581 pounds of haddock, flounders, cod, and other fishes valued at $2,126,728. Purse seines followed, with 12,912,964 pounds of mackerel and other fish valued at $743,776. Gill nets were fourth, with 12,058,391 pounds of mackerel, cod, herring, and other fish valued at $559,187. Swordfish and whales were taken with harpoons; clams, oysters, and scallops were taken with dredges; lobster pots took lobsters; and rakes took clams, all of which products made up the remainder of the yield in the vessel fisheries.

The yield of the boat fisheries was 54,596,571 pounds of fishery products, valued at $3,052,767; tongs, rakes, forks, and hoes, used in taking shellfish and Irish moss, produced the most valuable products in this fishery, which totaled 3,800,062 pounds, valued at $721,007. Lobster, crab, and eel pots were next, with 3,595,136 pounds, valued at $615,245. Lines followed, with 11,240,295 pounds of cod, haddock, and other fish, valued at $445,619. Pound and trap nets were next,

with a yield of 18,705,968 pounds of mackerel, herring, whiting, squid, and other species, valued at $389,178. Dredges, otter trawls, purse seines, gill nets, dip nets, haul seines, harpoons, fyke nets, spears, and cockle traps, named in order of value, yielded the remainder of the products in the shore and boat fisheries.

Wholesale trade and industries.—In the wholesale fishery trade there were 103 establishments, valued at $3,552,295, which used cash capital to the amount of $1,010,900 and employed 1,077 persons, to whom $1,566,654 was paid in salaries and wages. Canning, salting, smoking, and by-products manufacture were carried on by 47 establishments, valued at $2,004,023 and using cash capital of $365,800, which employed 1,075 persons, to whom $1,161,550 was paid in salaries and wages, and manufactured products to the value of $4,259,527.

The following tables and summary statements present the detailed statistics of the fisheries of Massachusetts in 1924.[14]

Yield of the vessel fisheries of Massachusetts in 1924, by apparatus and species

Species	Purse seines		Gill nets		Otter trawls		Lines	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives	170,767	$2,989						
Bluefish							55,325	$14,767
Butterfish	3,524	692	6,884	$586	29,388	$5,092	202	52
Cod, fresh	21,490	860	3,466,047	168,095	7,082,923	271,166	45,392,671	1,533,744
Cod, salted							3,065,461	139,634
Cunner					367	18		
Cusk, fresh			2,128	53	33,970	1,689	2,500,680	48,855
Cusk, salted							58,140	1,381
Eels					12	2	500	90
Flounders			12,893	196	16,535,740	731,296	7,230	367
Haddock, fresh			793,877	32,840	35,099,972	1,028,205	38,643,359	1,128,220
Haddock, salted							323	8
Hake, fresh			122,521	3,340	962,644	23,715	4,834,381	122,552
Hake, salted					1,150	32	26,939	469
Halibut, fresh			10	2	91,904	16,955	4,256,605	747,989
Halibut, salted							1,530	166
Herring, fresh	453,450	6,367	105	2				
Herring, salted			2,763,480	103,871				
Mackerel, fresh	10,667,415	638,742	2,469,744	183,506				
Mackerel, salted	1,222,270	88,658	11,824	860				
Menhaden	300,000	3,000						
Pollock, fresh	11,218	449	2,254,713	61,116	929,788	35,947	1,325,068	48,475
Pollock, salted							10,660	195
Rosefish					75,890	1,612	1,080	29
Scup							800	80
Sea bass							17,250	1,725
Shad	62,830	2,019	658	42				
Sharks			5,659	184	55	5	140	3
Skates					29,160	613		
Sturgeon			363	68	3,362	934		
Tautog							1,000	120
Tilefish							38,000	3,040
Wolf fish			100	2	170,024	4,316	41,340	1,017
Squid							585	28
Spawn			70	3	78,232	5,131	130,119	7,617
Livers			147,315	4,421			7,810	196
Total	12,912,964	743,776	12,058,391	559,187	61,124,581	2,126,728	100,417,198	3,800,819

Species	Harpoons		Lobster pots		Dredges		Rakes	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Swordfish	1,635,352	$330,575						
Clams, hard					189,160	$47,050	16,720	$5,861
Oyster, market, private					188,251	86,036		
Scallops					30,498	10,684		
Scallops, sea					18,000	6,550		
Lobsters			75,780	$23,155				
Sperm oil	99,227	6,410						
Total	1,734,579	336,985	75,780	23,155	425,909	150,320	16,720	5,861

[14] For statistics on persons engaged, vessels, boats, gear, and investment in the fisheries refer to page 296.

Yield of the shore and boat fisheries of Massachusetts in 1924, by apparatus and species

Species	Gill nets		Pound nets and trap nets		Otter trawls		Lines	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives, fresh	3,000	$120	317,537	$3,357				
Bluefish	515	198	5,336	878				
Bonito	2,820	327	10,447	865				
Butterfish	8,055	805	314,856	33,434			700	$75
Cod, fresh	97,322	4,232	67,838	2,132	51,407	$1,888	6,414,282	267,386
Cod, salted							133,600	8,016
Cusk, fresh							63,230	1,421
Eels			6,243	345			4,685	680
Flounders	5,800	290	33,686	1,474	6,253,673	267,341	145,559	8,007
Grayfish			17,850	320				
Haddock, fresh	74,134	2,928	4,366	107	346,161	9,963	2,721,515	84,606
Hake, fresh	32,913	1,034	27,732	580	50,559	1,334	653,576	18,082
Halibut, fresh					10	2	9,860	1,826
Herring, fresh	83,900	1,719	4,776,701	57,544				
Hickory shad			3,895	157				
Mackerel, fresh	987,787	56,605	4,079,056	154,118			95,316	6,392
Menhaden			221,864	1,843				
Pollock, fresh	9,390	390	65,603	2,108	18,434	723	713,269	24,631
Rosefish					10,486	158	147	3
Salmon			117	25				
Scup	1,000	85	115,346	6,426	200	30	40,975	3,314
Sea bass			4,175	536	840	101	3,990	404
Shad	3,250	325	105,564	6,003				
Sharks	1,172	26	18,130	747				
Skates			8,859	124			2,960	58
Smelt			168	28			37,530	9,795
Squeteagues			1,646	284				
Striped bass			68	21				
Sturgeon	1,500	515	580	165				
Sturgeon roe	50	50	54	68				
Tautog	3,500	350	13,339	1,192			113,300	9,850
Tomcod			2,191	74				
Tuna or "horse mackerel"			122,913	5,604				
Whiting	1,100	11	6,295,472	56,429			10,000	300
Wolffish					1,880	28	5,646	108
Other fish			20,393	613				
Squid			2,043,943	51,577			60,000	450
Spawn					1,640	49	9,695	201
Livers							460	14
Total	1,317,208	70,010	18,705,968	389,178	6,735,290	281,617	11,240,295	445,619

Species	Purse seines		Haul seines		Fyke nets		Dip nets	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives, fresh			791,600	$8,922			864,000	$7,320
Alewives, salted			54,930	2,612			242,000	6,050
Butterfish	14,320	$1,289						
Cod, fresh	22,000	880						
Eels			92,000	1,840	37,570	$4,817		
Flounders					1,500	60		
Herring, fish	495,630	4,956					3,225,238	29,764
Mackerel, fresh	2,142,419	113,060						
Mummichog							330	100
Pollock, fresh	11,000	440						
Striped bass			955	239				
Tautog			75	8				
White perch			27,600	3,525				
Scallops							1,800	540
Shrimp							750	600
Alewife scales							3,000	1,500
Total	2,685,369	120,625	967,160	17,146	39,070	4,877	4,337,118	45,874

Yield of the shore and boat fisheries of Massachusetts in 1924, by apparatus and species—Continued

Species	Harpoons		Spears		Lobster pots, crab pots, and eel pots		Cockle traps	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Eels			32,405	$4,002	240,317	$27,098		
Swordfish	97,640	$17,046						
Cockles							9,280	$3,839
Crabs, hard					1,750,998	53,865		
Lobsters					1,603,821	534,282		
Total	97,640	17,046	32,405	4,002	3,595,136	615,245	9,280	3,839

Species	Dredges		Tongs, rakes, forks, and hoes		Hand	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Clams, hard, public	252,456	$66,169	757,432	$238,394	2,000	$915
Clams, hard, private			4,000	1,500		
Clams, soft, public			2,381,750	280,668		
Clams, soft, private			138,600	17,095		
Clams, razor			22,800	3,040		
Oysters, market, private	62,300	17,075	280,700	164,700		
Oysters, seed, public			47,600	5,325		
Oysters, seed, private	70,000	8,400	49,000	4,050		
Scallops	523,734	180,643	3,180	1,060	180	60
Scallops, sea	120,600	42,100				
Cockles					3,300	1,320
Irish moss			115,000	5,175		
Total	1,029,090	314,387	3,800,062	721,007	5,480	2,295

Summary of the yield

Species	Shore fisheries		Vessel fisheries		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives, fresh	1,976,137	$19,719	170,767	$2,989	2,146,904	$22,708
Alewives, salted	296,930	8,662			296,930	8,662
Bluefish	5,851	1,076	55,325	14,767	61,176	15,843
Bonito	13,267	1,192			13,267	1,192
Butterfish	337,931	35,603	39,998	6,422	377,929	42,025
Catfish and wolf fish	7,526	136	211,464	5,335	218,990	5,471
Cod, fresh	6,652,849	276,518	55,963,131	1,973,865	62,615,980	2,250,383
Cod, salted	133,600	8,016	3,065,461	139,634	3,199,061	147,650
Cunner			367	18	367	18
Cusk, fresh	63,230	1,421	2,536,778	50,597	2,600,008	52,018
Cusk, salted			58,140	1,381	58,140	1,381
Eels	413,220	38,782	512	92	413,732	38,874
Flounders	6,440,218	277,172	16,555,863	731,859	22,996,081	1,009,031
Gray fish	17,850	320			17,850	320
Haddock, fresh	3,146,176	97,604	74,537,208	2,189,265	77,683,384	2,286,869
Haddock, salted			323	8	323	8
Hake, fresh	764,780	21,030	5,919,546	149,607	6,684,326	170,637
Hake, salted			28,089	501	28,089	501
Halibut, fresh	9,870	1,828	4,348,519	764,946	4,358,389	766,774
Halibut, salted			1,530	166	1,530	166
Herring, fresh	8,581,469	93,983	453,555	6,369	9,035,024	100,352
Herring, salted			2,763,480	103,871	2,763,480	103,871
Hickory shad	3,895	157			3,895	157
Mackerel, fresh	7,304,578	330,175	13,137,159	822,248	20,441,737	1,152,423
Mackerel, salted			1,234,094	89,518	1,234,094	89,518
Menhaden	221,864	1,843	300,000	3,000	521,864	4,843
Mummichog	330	100			330	100
Pollock, fresh	817,696	28,292	4,520,787	145,987	5,338,483	174,279
Pollock, salted			10,660	195	10,660	195
Rosefish	10,633	161	76,970	1,641	87,603	1,802
Salmon	117	25			117	25
Scup	157,521	9,855	800	80	158,321	9,935
Sea bass	9,005	1,041	17,250	1,725	26,255	2,766
Shad	108,814	6,328	63,488	2,061	172,302	8,389
Sharks	19,302	773	5,854	192	25,156	965
Skates	11,819	182	29,160	613	40,979	795
Smelt	37,698	9,823			37,698	9,823
Squeteagues	1,646	284			1,646	284
Striped bass	1,023	260			1,023	260
Sturgeon	2,080	680	3,725	1,002	5,805	1,682
Sturgeon roe	104	118			104	118

Summary of the yield—Continued

Species	Shore fisheries		Vessel fisheries		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Swordfish	97,640	$17,046	1,635,352	$330,575	1,732,992	$347,621
Tautog	130,214	11,400	1,000	120	131,214	11,520
Tilefish			38,000	3,040	38,000	3,040
Tomcod	2,191	74			2,191	74
Tuna or horse mackerel	122,913	5,604			122,913	5,604
Whiting	6,306,572	56,740			6,306,572	56,740
White perch	27,600	3,525			27,600	3,525
Other fish	20,393	613			20,393	613
Squid	2,103,943	52,027	585	28	2,104,528	52,055
Clams, hard, public	1,011,888	305,478	205,880	52,911	1,217,768	358,389
Clams, hard, private	4,000	1,500			4,000	1,500
Clams, soft, public	2,381,750	280,668			2,381,750	280,668
Clams, soft, private	138,600	17,095			138,600	17,095
Clams, razor	22,800	3,040			22,800	3,040
Oysters, market, private	343,000	181,775	188,251	86,036	531,251	267,811
Oysters, seed, public	47,600	5,325			47,600	5,325
Oysters, seed, private	119,000	12,450			119,000	12,450
Scallops	528,894	182,303	30,498	10,684	559,392	192,987
Scallops, sea	120,600	42,100	18,000	6,550	138,600	48,650
Cockles	12,580	5,159			12,580	5,159
Crabs, hard	1,750,998	53,865			1,750,998	53,865
Lobsters	1,603,821	534,282	75,780	23,155	1,679,601	557,437
Shrimp	750	600			750	600
Spawn	11,335	250	208,421	12,751	219,756	13,001
Livers	460	14	155,125	4,617	155,585	4,631
Sperm oil			99,227	6,410	99,227	6,410
Alewife scales	3,000	1,500			3,000	1,500
Irish moss	115,000	5,175			115,000	5,175
Total	54,596,571	3,052,767	188,766,122	7,746,831	243,362,693	10,799,598

Summary by counties

County	Persons engaged	Investment	Products	
	Number	*Dollars*	*Pounds*	*Value*
Barnstable	1,374	952,186	32,830,492	$1,566,717
Bristol	528	386,752	6,547,345	452,814
Dukes	378	336,381	4,344,267	441,101
Essex	2,541	3,294,379	95,893,555	4,345,974
Nantucket	246	328,429	5,115,613	393,747
Norfolk	77	18,990	179,785	39,981
Plymouth	795	130,799	2,861,539	285,030
Suffolk	1,184	2,981,082	95,590,097	3,274,224
Total	7,123	8,428,998	243,362,693	10,799,598

RHODE ISLAND

In 1924 Rhode Island ranked fourth among the New England States in the number of persons engaged, investment, and yield of her fisheries. The total number of persons employed was 1,176, of whom 334 were on fishing vessels, two on transporting vessels, and 840 in the shore or boat fisheries. The investment in the fisheries amounted to $1,135,567 and included 81 vessels valued, together with their outfits, at $429,353; 511 motor boats valued at $229,800; 482 sail and row boats valued at $18,977; gear to the value of $276,517; and shore and accessory property valued at $180,920. The total yield of the fisheries amounted to 20,535,327 pounds of fishery products, valued at $1,818,858. The leading products, named in order of value, were lobsters, 1,696,346 pounds, valued at $462,000; oysters, 2,583,686 pounds, valued at $458,364; mackerel, 2,380,700 pounds, valued at $156,933; and flounders, 3,099,425 pounds, valued at $118,915.

Fisheries.—The yield of the vessel fisheries amounted to 12,342,412 pounds, valued at $868,501. Dredges were most important in the

vessel fisheries, yielding 2,550,786 pounds, valued at $451,545, consisting almost entirely of oysters. Trap nets were next, with a yield of 4,319,015 pounds, valued at $174,945, of which mackerel and scup were the most important. Otter trawls yielded 2,178,650 pounds, valued at $79,068, most of which were flounders. Purse seines, lines, harpoons, lobster pots, gill nets, and tongs, named in order of importance, made up the remainder of the shore and vessel fisheries.

The shore and boat fisheries yielded 8,192,915 pounds of fishery products, valued at $950,357. Lobster pots yielded 1,657,079 pounds, valued at $438,888. Pound and trap nets took 4,162,046 pounds, valued at $184,866, consisting of various species of fish, the most important of which were mackerel, butterfish, scup, and flounders. Tongs, rakes, hoes, forks, and shovels together yielded 515,900 pounds of clams and oysters, valued at $149,980. Dredges, lines, haul seines, otter trawls, harpoons, eel pots, fyke nets, spears, dip nets, winkle pots, and gill nets, named in order of importance, took the remainder of the yield of the shore and boat fishery.

Wholesale trade and industries.—The wholesale fishery trade was carried on in 25 establishments, valued at $284,563, carrying cash capital of $60,700 and employing 217 persons, to whom $173,604 were paid in salaries and wages. Canning and by-products industries were carried on in three establishments, detailed statistics of which may be found in the table including Rhode Island and Connecticut.

The following tables and summary statements present the detailed statistics of the fisheries of Rhode Island in 1924.[15]

Yield of the vessel fisheries of Rhode Island in 1924, by apparatus and species

Species	Purse seines		Gill nets		Trap nets		Lines	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives					47,000	$940		
Bluefish					1,400	280		
Bonito					3,000	312		
Butterfish			1,000	$80	380,000	21,560		
Cod					142,000	7,100	595,380	$30,104
Eels					600	60		
Flounders					232,000	11,300		
Grayfish					600	12		
Haddock					6,000	300	50,400	1,812
Hake					1,000	40	9,000	185
Herring	50,000	$1,000			60,000	1,200		
Hickory shad					3,800	190		
Mackerel	640,398	44,561	170,750	14,098	730,000	43,900	31,025	1,687
Menhaden	1,400,000	14,000	50,000	500	19,000	190		
Pollock					18,600	800	21,000	590
Pompano					100	20		
Salmon			50	4	40	14		
Sculpin					8,000	80		
Scup					744,000	37,200		
Sea bass					25,400	2,540		
Sea robin					55,000	750		
Shad					800	200		
Sharks					2,000	40		
Skates					5,600	112		
Squeteagues					16,600	2,490		
Striped bass					49,000	9,120		
Sturgeon					1,400	280		
Sturgeon roe					75	94		
Tautog					5,600	448	23,750	2,035
Tuna					35,400	4,248		
Whiting					1,280,000	18,800		
Squid					445,000	10,325		
Total	2,090,398	59,561	221,800	14,682	4,319,015	174,945	730,555	36,413

[15] For statistics on persons engaged, vessels, boats, gear, and investment in the fisheries refer to page 297.

Yield of the vessel fisheries of Rhode Island in 1924, by apparatus and species—Continued

Species	Otter trawls		Harpoons		Lobster pots		Dredges and tongs	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Cod	10,000	$500						
Flounders	2,161,850	78,359						
Haddock	5,800	194						
Hake	1,000	15						
Swordfish			159,541	$27,425				
Lobsters					89,267	$24,112		
Clams, hard							[1] 2,400	$750
Oysters, market, private							[2] 2,548,686	450,864
Scallops							[2] 2,100	681
Total	2,178,650	79,068	159,541	27,425	89,267	24,112	2,553,186	452,295

[1] Taken by tongs. [2] Taken by dredges.

Yield of the shore and boat fisheries of Rhode Island in 1924, by apparatus and species

Species	Haul seines		Pound nets and trap nets		Fyke nets		Lines	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives, fresh	10,000	$300	303,737	$6,563				
Alewives, smoked	15,000	225						
Bluefish			2,236	503				
Bonito			1,505	126				
Butterfish			304,450	24,041				
Cod			18,300	939			590,250	$29,613
Cunner			600	18	4,000	$80		
Eels	19,800	2,248	42,600	4,426	5,200	580	24,750	3,142
Flounders	4,200	198	345,075	17,628	25,000	1,250	3,300	180
Goosefish			300	6				
Grayfish			3,500	35				
Haddock							69,000	2,070
Hake			1,000	30			26,000	390
Herring	100,000	2,050	296,900	6,044				
Hickory shad			11,700	545				
Mackerel			759,527	50,037			49,000	2,650
Menhaden			274,025	2,591				
Mummichog	8,000	2,880						
Pollock			36,600	1,350			40,000	1,000
Pompano			25	7				
Sculpin			5,000	50				
Scup			447,625	22,451				
Sea bass			26,800	2,285				
Sea robin			119,200	1,212				
Shad			10,182	2,595				
Sharks			2,000	34				
Skates			8,100	130				
Smelt	200	60	7,660	1,532				
Squeteagues	2,000	200	40,154	5,921				
Striped bass	4,000	1,000	14,910	2,769				
Sturgeon			240	44				
Tautog	3,250	235	94,500	7,980	13,000	1,075	51,200	4,260
Tomcod	400	12	3,850	129				
Tuna			5,500	555				
White perch	2,600	510	2,150	405				
Whiting			464,200	8,864				
Yellow perch			195	24				
Shrimp	4,000	2,400						
Squid			507,700	12,997				
Total	173,450	12,318	4,162,046	184,866	47,200	2,985	853,500	43,305

Species	Gill nets		Dip nets		Otter trawls		Harpoons	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Bluefish	100	$15						
Cod					1,000	$40		
Cunner			25,350	$836				
Flounders					328,000	10,000		
Haddock					3,000	90		
Squeteagues	500	10						
Striped bass	50	10						
Swordfish							46,500	$7,500
Total	650	35	25,350	836	332,000	10,130	46,500	7,500

Yield of the shore and boat fisheries of Rhode Island in 1924, by apparatus and species—Continued

Species	Lobster, eel, and winkle pots		Spears		Dredges		Tongs, rakes, hoes, forks, and shovels	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Eels	[1] 59,200	$6,184	16,300	$2,016				
Lobsters	[2] 1,607,079	437,888						
Crabs, hard	[2] 50,000	1,000						
Clams, hard							430,000	$133,750
Clams, soft							82,480	15,480
Oysters, market, public							3,500	750
Oysters, market, private					31,500	$6,750		
Scallops					268,740	83,864		
Winkles	[3] 3,500	700						
Total	1,719,779	445,772	16,300	2,016	300,240	90,614	515,900	149,980

[1] Taken by eel pots. [2] Taken by lobster pots. [3] Taken by winkle pots.

Summary of the yield

Species	Shore fisheries		Vessel fisheries		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives, fresh	313,737	$6,863	47,000	$940	360,737	$7,803
Alewives, smoked	15,000	225			15,000	225
Bluefish	2,336	518	1,400	280	3,736	798
Bonito	1,505	126	3,000	312	4,505	438
Butterfish	304,450	24,041	381,000	21,640	685,450	45,681
Cod	609,550	30,592	747,380	37,704	1,356,930	68,296
Cunner	29,950	934			29,950	934
Eels	167,850	18,596	600	60	168,450	18,656
Flounders	705,575	29,256	2,393,850	89,659	3,099,425	118,915
Goosefish	300	6			300	6
Grayfish	3,500	35	600	12	4,100	47
Haddock	72,000	2,160	62,200	2,306	134,200	4,466
Hake	27,000	420	11,000	240	38,000	660
Herring	396,900	8,094	110,000	2,200	506,900	10,294
Hickory shad	11,700	545	3,800	190	15,500	735
Mackerel	808,527	52,687	1,572,173	104,246	2,380,700	156,933
Menhaden	274,025	2,591	1,469,000	14,690	1,743,025	17,281
Mummichog	8,000	2,880			8,000	2,880
Pollock	76,600	2,350	39,600	1,390	116,200	3,740
Pompano	25	7	100	20	125	26
Salmon			90	18	90	18
Sculpin	5,000	50	8,000	80	13,000	130
Scup	447,625	22,451	744,000	37,200	1,191,625	59,651
Sea bass	26,800	2,285	25,400	2,540	52,200	4,825
Sea robin	119,200	1,212	55,000	750	174,200	1,962
Shad	10,182	2,595	800	200	10,982	2,795
Sharks	2,000	34	2,000	40	4,000	74
Skates	8,100	130	5,600	112	13,700	242
Smelt	7,860	1,592			7,860	1,592
Squeteagues	42,654	6,131	16,600	2,490	59,254	8,621
Striped bass	18,960	3,779	49,000	9,120	67,960	12,899
Sturgeon	240	44	1,400	280	1,640	324
Sturgeon roe			75	94	75	94
Swordfish	46,500	7,500	159,541	27,425	206,041	34,925
Tautog	161,950	13,550	29,350	2,483	191,300	16,033
Tomcod	4,250	141			4,250	141
Tuna	5,500	555	35,400	4,248	40,900	4,803
White perch	4,750	915			4,750	915
Whiting	464,200	8,864	1,280,000	18,800	1,744,200	27,664
Yellow perch	195	24			195	24
Lobsters	1,607,079	437,888	89,267	24,112	1,696,346	462,000
Shrimp	4,000	2,400			4,000	2,400
Crabs, hard	50,000	1,000			50,000	1,000
Squid	507,700	12,997	445,000	10,325	952,700	23,322
Clams, hard	430,000	133,750	2,400	750	432,400	134,500
Clams, soft	82,400	15,480			82,400	15,480
Oysters, market, public	3,500	750			3,500	750
Oysters, market, private	31,500	6,750	2,548,686	450,864	2,580,186	457,614
Scallops	268,740	83,864	2,100	681	270,840	84,545
Winkles	3,500	700			3,500	700
Total	8,192,915	950,357	12,342,412	868,501	20,535,327	1,818,858

Summary by counties

County	Persons engaged	Investment	Products	
	Number	*Dollars*	*Pounds*	*Value*
Bristol	69	64, 247	862, 339	$177, 871
Kent	214	61, 121	590, 610	175, 065
Newport	616	768, 683	15, 004, 725	905, 281
Providence	108	106, 328	1, 976, 894	317, 599
Washington	169	135, 188	2, 100, 759	243, 042
Total	1, 176	1, 135, 567	20, 535, 327	1, 818, 858

CONNECTICUT

In 1924 Connecticut ranked third among the New England States in the size and value of her fisheries. There were 1,298 persons engaged in it, including 574 on fishing vessels, 17 on transporting vessels, and 707 in shore or boat fisheries. The investment amounted to $1,593,472, which included 130 fishing and transporting vessels, valued, together with their outfits, at $1,010,667; 385 motor boats valued at $263,075; 511 sail and row boats valued at $25,605; fishing gear and apparatus valued at $61,304, and shore and accessory property valued at $232,821. The products of the fisheries amounted to 25,769,516 pounds, valued at $2,006,658. The most important products were oysters, 8,020,292 pounds, valued at $1,326,056; flounders, 4,415,927 pounds, valued at $197,507; lobsters, 701,647 pounds, valued at $240,809; and menhaden, 5,270,020 pounds, valued at $56,437.

Fisheries.—The yield of fishery products by vessels totaled 15,878,216 pounds, valued at $1,495,943. The yield by dredges amounted to 7,753,718 pounds of oysters, valued at $1,282,100, making this by far the most important gear operated in the vessel fisheries. Otter trawls were next, with a yield of 2,046,360 pounds, valued at $94,581, consisting mostly flounders. Purse seines followed, with a yield of 5,387,150 pounds, valued at $65,245, which consisted largely of menhaden with lesser amounts of mackerel and squeteagues. Lines, harpoons, lobster pots, tongs, and eel pots, named in order of importance, took the remainder of the yield by fishing vessels.

The yield of the shore and boat fisheries amounted to 9,891,300 pounds, valued at $510,715. Lobster pots produced the most valuable share, consisting of 684,923 pounds of lobsters valued at $233,950. Otter trawls were next, with 2,397,165 pounds, valued at $103,257, consisting almost entirely of flounders. Tongs were third, with a yield of 5,520,217 pounds of shells and shellfish, valued at $31,581; dredges took 160,299 pounds of oysters and scallops, valued at $26,218; and lines yielded 313,292 pounds of various kinds of fish, valued at $24,477. Gill nets, rakes, pound and trap nets, haul seines, fyke nets, eel pots, harpoons, spears, purse seines, dip nets, crab pots, and minor apparatus, named in order of importance, took the remainder of the products in the shore and boat fisheries.

Wholesale trade and industries.—In the wholesale fishery trade there were 17 establishments, valued at $299,100, with cash capital of $75,500 and employing 357 persons, to whom $228,659 were paid in salaries and wages. There were also two establishments engaged in manufacturing by-products, the details of which are included with the statistics for Rhode Island.

The following tables and summary statements present the detailed statistics of the fisheries of Connecticut in 1924.[16]

Yield of the vessel fisheries of Connecticut in 1924, by apparatus and species

Species	Purse seines		Lines		Otter trawls		Harpoons	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Cod			392, 587	$23, 650	14, 600	$727		
Flounders					2, 002, 660	92, 180		
Haddock			2, 100	105	27, 550	1, 395		
Hake			500	20	500	16		
Mackerel	157, 514	$8, 739	4, 400	240				
Menhaden	5, 225, 220	56, 000						
Pollock			30, 100	1, 205				
Squeteagues	4, 416	506						
Swordfish							43, 022	$7, 390
Tautog			225	18				
Tilefish			200, 130	14, 170				
Scallops					1, 050	263		
Total	5, 387, 150	65, 245	630, 042	39, 408	2, 046, 360	94, 581	43, 022	7, 3 9

Species	Lobster pots		Eel pots		Dredges		Tongs	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Eels			400	$60				
Lobsters	16, 724	$6, 859						
Clams, hard							800	$300
Oysters, market, private					4, 079, 362	$668, 536		
Oysters, seed, public					222, 740	33, 800		
Oysters, seed, private					3, 451, 616	579, 764		
Total	16, 724	6, 859	400	60	[1] 7, 753, 718	1, 282, 100	800	300

[1] Includes 17,742 bushels, or 124,194 pounds, of market oysters, valued at $21,907, and 25,342 bushels, or 117,394 pounds, of seed oysters, valued at $20,842, taken by New York and Rhode Island vessels in Connecticut waters.

[16] For statistics on persons engaged, vessels, boats, gear, and investment in the fisheries refer to page 297.

Yield of the shore and boat fisheries of Connecticut in 1924, by apparatus and species

Species	Haul seines		Pound nets and trap nets		Fyke nets		Lines	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives, fresh	54,838	$1,175	42,300	$1,016	1,175	$33		
Alewives, salted	11,662	275						
Bluefish			81	16			17,160	$4,498
Bullheads			50	3	750	46		
Butterfish			5,650	442				
Carp	26,753	3,752	2,200	300	4,880	546		
Cod			200	10			112,100	5,605
Eels	30	3	6,130	630	10,058	1,405	100	20
Flounders			43,407	3,415	6,865	563	2,200	150
Haddock							3,800	190
Hake			200	4			1,600	64
Herring			100	2				
Hickory shad			1,900	83				
Mackerel			18,970	1,859			89,376	6,541
Menhaden			43,800	428	1,000	10		
Mummichog	1,500	400						
Pickerel	100	9			455	53		
Pollock							18,100	736
Roach or shiners	1,000	4			1,110	51		
Scup			1,750	176				
Sea bass			50	9			3,100	460
Sea robin			25	1				
Shad	18,974	3,845	2,779	736				
Skates			200	4				
Smelt	6,300	1,610	1,000	200				
Squeteagues			32,699	4,172	25	3	3,695	621
Striped bass			1,485	382	10	2	50	12
Sturgeon			100	25				
Suckers	38,990	2,545	9,800	694	70,884	4,785		
Tautog			10,400	636			62,011	5,580
Tomcod			50	3	140	4		
Whitebait	1,005	195			600	36		
White perch					50	6		
Whiting			2,000	40				
Yellow perch	860	73	175	12	2,361	252		
Squid			16,630	484				
Total	162,012	13,886	244,131	15,782	100,363	7,795	313,292	24,477

Species	Purse seines		Gill nets		Dip nets		Otter trawls	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives					500	$10		
Carp			5,500	$660				
Cod							19,400	$980
Flounders							2,360,795	101,199
Haddock							15,500	750
Hake							200	4
Mackerel	33,600	$2,688						
Shad			66,730	16,208	325	66		
Smelt					4,000	600		
Sturgeon							190	54
Crabs, hard					440	28		
Scallops							1,080	270
Oysters, market, public					210	90		
Total	33,600	2,688	72,230	16,868	5,475	794	2,397,165	103,257

Species	Harpoons		Lobster pots		Eel pots		Crab pots	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Cunner					200	$10		
Eels					68,440	7,073		
Swordfish	37,123	$6,506						
Crabs, sand							10,000	$250
Lobsters			684,923	$233,950				
Total	37,123	6,506	684,923	233,950	68,640	7,083	10,000	250

Yield of the shore and boat fisheries of Connecticut in 1924, etc.—Continued

Species	Dredges		Tongs		Rakes		Spears and minor traps	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Eels							[1] 27,300	$3,215
Mummichog							1,200	320
Clams, hard, public			14,416	$6,415	6,880	$3,290		
Clams, hard, private			1,536	768				
Clams, soft					44,350	12,155		
Scallops	300	$150						
Oysters, market, public	14,000	3,000	4,200	775				
Oysters, market, private	41,139	7,138	17,815	6,760	2,100	600		
Oysters, seed, public	87,360	13,430	73,850	8,703				
Oysters, seed, private	17,500	2,500	8,400	960				
Oyster shells			5,400,000	7,200				
Total	160,299	26,218	5,520,217	31,581	53,330	16,045	28,500	3,535

[1] Of this amount 27,200 pounds, valued at $3,200, were taken by spears.

Summary of the yield

Species	Shore fisheries		Vessel fisheries		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Alewives, fresh	98,813	$2,234			98,813	$2,234
Alewives, salted	11,662	275			11,662	275
Bluefish	17,241	4,514			17,241	4,514
Bullheads	800	49			800	49
Butterfish	5,650	442			5,650	442
Carp	39,333	5,258			39,333	5,258
Cod	131,700	6,595	407,187	$24,377	538,887	30,972
Cunner	200	10			200	10
Eels	112,058	12,346	400	60	112,458	12,406
Flounders	2,413,267	105,327	2,002,660	92,180	4,415,927	197,507
Haddock	19,300	940	29,650	1,500	48,950	2,440
Hake	2,000	72	1,000	36	3,000	108
Herring	100	2			100	2
Hickory shad	1,900	83			1,900	83
Mackerel	141,946	11,088	161,914	8,979	303,860	20,067
Menhaden	44,800	438	5,225,220	56,000	5,270,020	56,438
Mummichog	2,700	720			2,700	720
Pickerel	555	62			555	62
Pollock	18,100	736	30,100	1,205	48,200	1,941
Roach or shiners	2,110	55			2,110	55
Scup	1,750	176			1,750	176
Sea bass	3,150	469			3,150	469
Sea robin	25	1			25	1
Shad	88,808	20,855			88,808	20,855
Skates	200	4			200	4
Smelt	11,300	2,410			11,300	2,410
Squeteagues	36,419	4,796	4,416	506	40,835	5,302
Striped bass	1,545	396			1,545	396
Sturgeon	290	79			290	79
Suckers	119,674	8,024			119,674	8,024
Swordfish	37,123	6,506	43,022	7,390	80,145	13,896
Tautog	72,411	6,216	225	18	72,636	6,234
Tilefish			200,130	14,170	200,130	14,170
Tomcod	190	7			190	7
Whitebait	1,605	231			1,605	231
White perch	50	6			50	6
Whiting	2,000	40			2,000	40
Yellow perch	3,396	337			3,396	337
Crabs, hard	440	28			440	28
Crabs, sand	10,000	250			10,000	250
Lobsters	684,923	233,950	16,724	6,859	701,647	240,809
Squid	16,630	484			16,630	484
Clams, hard, public	21,296	9,705	800	300	22,096	10,005
Clams, hard, private	1,536	768			1,536	768
Clams, soft	44,350	12,155			44,350	12,155
Scallops	1,380	420	1,050	263	2,430	683
Oysters, market, public	18,410	3,865			18,410	3,865
Oysters, market, private	61,054	14,498	4,079,362	668,536	4,140,416	683,034
Oysters, seed, public	161,210	22,133	222,740	33,800	383,950	55,933
Oysters, seed, private	25,900	3,460	3,451,616	579,764	3,477,516	583,224
Oyster shells	5,400,000	7,200			5,400,000	7,200
Total	9,891,300	510,715	15,878,216	1,495,943	25,769,516	2,006,658

Summary by counties

County	Persons engaged	Investment	Products	
	Number	*Dollars*	*Pounds*	*Value*
Fairfield	442	658, 010	10, 761, 150	$869, 973
Hartford	51	4, 978	162, 084	12, 517
Middlesex	137	45, 465	344, 154	53, 575
New Haven	251	428, 726	3, 237, 691	554, 118
New London	417	456, 293	11, 264, 437	516, 475
Total	1, 298	1, 593, 472	25, 769, 516	2, 006, 658

PROPAGATION AND DISTRIBUTION OF FOOD FISHES, FISCAL YEAR 1926 [1]

By Glen C. Leach, *Assistant in Charge, Division of Fish Culture*

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INTRODUCTION

Probably the most popular and educational feature of the fish-cultural work of the Bureau of Fisheries during the past fiscal year was the development and extension of the fish-nursery project that was inaugurated during the last half of the previous fiscal year. This work is being enlarged as rapidly as facilities will permit and at the present time provides not only for the rearing of trout but also for the production of large fingerling black bass, crappie, and bream on a cooperative basis. The most enthusiastic interest in this undertaking thus far shown has been manifested by fishing clubs and similar organizations in the States of Pennsylvania, Wisconsin, and Minnesota.

The output of fingerling fish in 1926 was almost twice that of the preceding year, due to the special efforts made to rear fish at every point where suitable facilities for such work exist. The public demand for fingerling fish is increasing rapidly, and it is doubtful whether there is any way of meeting it except by arranging with various fish and game organizations throughout the country to rear a large proportion of the small fish incubated each year at the Federal hatcheries. Such assistance would not only relieve the crowded condition of these hatcheries during the spring months, but it would enable the bureau to produce larger numbers of small fish than heretofore. The greatest value of the cooperative nursery work, however, doubtless lies in the increasing interest it is bound to incite on the part of the general public in the protection of fish in the open waters. In view of the fact that virtually all of the organizations participating in such cooperation have memberships of from 1,000 to 5,000, the extent of this beneficial influence can readily be realized. Each member of a cooperating association naturally will be interested not only in the success of the work in hand but in the protection of the fish after they are released. Some organizations have decided to prolong the rearing operations, holding the fish for from 15 to 18 months after receiving them from the bureau's hatcheries. If instead of being released as 3-inch or 4-inch fry in the fall of the year, as will be necessary in many instances, the fish can be held and fed until they are 18 months old and planted in October, many of them will have attained their first spawning period and will be of immediate benefit to the streams in which they are placed, while at the opening of the succeeding fishing season they will have reached the legal size for capture.

Thus far the Central Pennsylvania Fish and Game Protective Association has taken the lead in cooperative work. In connection with its nursery project, located at Chapel Hille, Pa., this organization has expended several thousand dollars in the purchase of equipment, and it is now considering the construction of a hatchery capable of handling from 500,000 to 1,000,000 trout eggs. If a hatchery of this size can be established, it will greatly relieve the strain on the Federal hatchery at White Sulphur Springs, W. Va., which at the present time is called upon to produce all fish required for waters in Pennsylvania.

With the view of meeting the greatest need of the bureau, which is for more bass, crappie, and other warm-water pond fishes, the propagation of such species on a large scale at a number of pond locations in various sections of the United States is being considered. If such plans can be carried out, ponds varying in size from 50 to 100 acres will be utilized for the production of fingerling fish, which will be distributed in the fall when 3 or 4 months old. For this purpose the bureau now is cooperating with the State of Florida in establishing bass hatcheries in that State. The Florida authorities are greatly interested in the fishing question because of the large number of visitors to the State during the winter. The tourist season and the spawning period of the bass overlap to a certain extent. It would be a rather delicate undertaking to refuse fishing privileges to tourists, but if fishing be permitted during the bass spawning season it will not be possible long to maintain the supply of bass in Florida waters. In propagating bass the greatest benefit will be derived from the development of public interest in protective measures.

The bureau continues to make annual collections of bass and other warm-water fishes from overflowed lands bordering the Mississippi River. These are distributed principally in waters in the States of Minnesota, Wisconsin, Iowa, and Illinois, only a very small number being sent to more remote points. During the year the station at La Crosse, Wis., made preparations for taking up the production of fish in the territory included in the upper Mississippi wild life and fish refuge. Boats and other movable equipment required for the work were obtained, but as the Government had not purchased any land under the provisions of the act creating this refuge no expenditures could be made for improvements to natural ponds. As soon as the property has been acquired the bureau will take steps to utilize the most suitable natural reservoirs for the breeding of fish.

On the Pacific coast, the Atlantic coast, and in the Great Lakes region the usual attention has been given to salvaging the eggs of the more important commercial fishes taken in the nets of the fishermen. At western stations as many of the small salmon produced from such eggs as facilities in the various fields would permit were held in nursery ponds and reared to the larger fingerling sizes before releasing them on local spawning grounds. Every spring spawn takers are sent out from the Gloucester (Mass.) station with vessels bound for the offshore fishing banks to take ripe spawn from the cod and haddock obtained in fishing operations. As a result of such work last season over 100,000,000 cod eggs and about 50,000,000 haddock eggs were fertilized and planted on the local spawning areas, their distance from land being too far to permit forwarding the spawn to the hatcheries for development. It is believed that this work is producing substantial results. In the Michigan field attention has been given to the production of lake-trout fingerlings, and if plans now under consideration can be put into execution it is purposed to rear several million lake trout annually in the vicinity of Alpena, Mich. This work can not be extended to the rearing of whitefish, as young fish of that species can not be fed artificially.

In connection with the propagation of buffalo fish in Louisiana, a new hatchery has been erected at Pelba, where a water supply

much better suited to the work than that at the former site will be available.

The degree of success attained in shad propagation at eastern stations of the bureau has not been encouraging. The practicability of rearing shad in ponds of 100 to 500 acres in area should be determined. It is quite apparent that if the supply of this valuable fish is to be maintained in Atlantic coastal streams scientific investigations should be made to determine what regulations are necessary. In the meantime it is suggested that an annual closed season that will shorten fishing operations be provided. In addition, a weekly closed period extending from sundown Friday to sunrise Monday should be adopted and the number of nets should be curtailed and the distance between them increased. Under existing conditions fishermen are allowed to operate their nets near the mouths of rivers and to catch shad before they are in spawning condition. If a sufficient number of shad can not reach their natural spawning grounds, it will not be possible for the hatcheries to accomplish anything in shad propagation owing to their inability to obtain ripe spawn for the work. The reservation of certain areas in which shad could be allowed to spawn without molestation of any kind would do much to assist in the rehabilitation of the species in eastern rivers. Pollution and the dumping of trade wastes into many important streams has had a harmful effect on the run of shad and should be prevented.

Part 1.—FISH PRODUCTION: PROPAGATION AND RESCUE WORK

SPECIES OF FISHES HANDLED

During the fiscal year 1926 the fish-cultural work of the bureau, including artificial propagation and rescue work, involved the handling of 45 species of fishes, as follows:

LIST OF SPECIES HANDLED

CATFISHES (SILURIDÆ):
- Channel catfish (*Ictalurus punctatus*).
- Horned pout, bullhead (*Ameiurus nebulosus*).
- Mud catfish (*Leptops olivaris*).

SUCKERS (CATOSTOMIDÆ):
- Common buffalo fish (*Ictiobus cyprinella*).
- Smallmouth buffalo fish (*Ictiobus bubalus*).
- Buffalo fish (*Ictiobus urus*).

CARPS (CYPRINIDÆ): German carp (*Cyprinus carpio*).

SHADS AND HERRINGS (CLUPEIDÆ):
- Shad (*Alosa sapidissima*).
- Glut herring (*Pomolobus æstivalis*).

SALMONS, TROUTS, WHITEFISHES, ETC. (SALMONIDÆ):
- Common whitefishes (*Coregonus albus* and *C. clupeaformis*).
- Cisco (*Argyrosomus artedi*).
- Chinook salmon, king salmon, quinnat salmon (*Oncorhynchus tschawytscha*).
- Chum salmon, dog salmon (*Oncorhynchus keta*).
- Humpback salmon, pink salmon (*Oncorhynchus gorbuscha*).
- Silver salmon, coho salmon (*Oncorhynchus kisutch*).
- Sockeye salmon, blueback salmon, red salmon (*Oncorhynchus nerka*).
- Steelhead salmon (*Salmo gairdneri*).
- Atlantic salmon (*Salmo salar*).
- Landlocked salmon (*Salmo sebago*).
- Rainbow trout (*Salmo shasta*).
- Black-spotted trout, redthroat trout (*Salmo lewisi*).
- Loch Leven trout (*Salmo levenensis*).
- Lake trout, Mackinaw trout (*Cristivomer namaycush*).
- Brook trout (*Salvelinus fontinalis*).
- Brown trout (*Salmo fario*).

GRAYLINGS (THYMALLIDÆ): Montana grayling (*Thymallus montanus*).

PIKES (ESCOIDÆ): Common pickerel (*Esox lucius*).

SUNFISHES, BLACK BASSES, AND CRAPPIES (*Centrarchidæ*):
- Crappies (*Pomoxis annularis* and *P. sparoides*).
- Largemouth black bass (*Micropterus salmoides*).
- Smallmouth black bass (*Micropterus dolomieu*).
- Rock bass (*Ambloplites rupestris*).
- Warmouth bass, goggle-eye (*Chænobryttus gulosus*).
- Green sunfish (*Apomotis cyanellus*).
- Red-breasted bream (*Lepomis auritus*).
- Bluegill sunfish (*Lepomis pallidus*).
- Common sunfish (*Eupomotis gibbosus*).

PERCHES (PERCIDAE):
- Pike perch (*Stizostedion vitreum*).
- Yellow perch, ringed perch (*Perca flavescens*).

SEA BASSES (SERRANIDÆ): White bass (*Roccus chrysops*).

DRUMS (SCIÆNIDÆ): Fresh-water drum, lake sheepshead (*Aplodinotus grunniens*).

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MACKEREL (SCOMBRIDÆ): Common mackerel (*Scomber scombrus*).
CODS (GADIDÆ):
Cod (*Gadus callarias*).
Haddock (*Melanogrammus æglifinus*).
Pollock (*Pollachius virens*).
FLOUNDERS (PLEURONECTIDÆ): Winter flounder, American flatfish (*Pseudopleuronectes americanus*).

COOPERATION WITH STATES, OTHER FEDERAL AGENCIES, AND FOREIGN GOVERNMENTS

The bureau has continued to supply eggs of the brook, rainbow, and black-spotted trouts to the Canadian Government in exchange for eggs of the Atlantic salmon. Such exchanges with foreign countries have been very advantageous, as they have been the means of placing at the bureau's disposal eggs of a kind that otherwise it would have been difficult to obtain. In several instances State fisheries authorities have exchanged eggs with the bureau, and the bureau frequently has supplied eggs to a State. The State of North Carolina has aided the bureau in securing a brood stock of black bass for its Edenton (N. C.) station and has materially assisted in other ways in increasing the production of fish at that station. The bureau has aided several States in establishing fish-cultural stations and has incubated and reared fish at its hatcheries for State institutions. Particularly favorable results along this line have been secured at the White Sulphur Springs (W. Va.) and Spearfish (S. Dak.) stations.

OUTPUT

The output of the fish-cultural stations and of the rescue fields bordering the Mississippi River aggregated 5,232,373,000 fish and fish eggs. Losses in transportation amounted to 47,828, leaving a net output of 5,232,325,172 actually distributed, which shows a falling off of approximately 69,500,000 as compared with last year's figures. Almost all of the commercial fishes produced were returned to the waters from which the eggs were derived. The output of fingerling fish in 1925, in round numbers, was 136,953,000, as compared with 299,294,700 in 1926.

Summary, by species, of the output of fish and fish eggs during the fiscal year ended June 30, 1926

Species	Eggs	Fry	Fingerlings	Total
Catfish		1,400,000	30,964,500	32,364,500
Buffalo fish		105,315,000	11,258,600	116,573,600
Carp		54,500,000	40,349,500	94,849,500
Sand perch			5,000	5,000
Shad		9,143,800		9,143,800
Glut herring		55,000,000		55,000,000
Whitefish	8,320,000	200,024,000		208,344,000
Cisco	10,080,000	85,000,000		95,080,000
Chinook salmon	11,284,600	800,000	50,837,300	62,921,900
Chum salmon		18,163,500		18,163,500
Silver salmon	211,000	4,555,800	5,134,900	9,901,700
Sockeye salmon	150,000	9,795,800	64,681,000	74,626,800
Humpback salmon		1,753,500	90,000	1,843,500
Steelhead salmon	1,133,800	1,029,500	4,324,500	6,487,800
Atlantic salmon	100,000	776,000	125,600	1,001,600
Landlocked salmon	383,900	432,100	270,600	1,086,600
Rainbow trout	2,827,500	1,540,800	3,621,100	7,989,400
Black-spotted trout	8,917,800	1,473,200	3,868,400	14,259,400
Loch Leven trout	3,894,500	616,000	2,987,000	7,497,500
Lake trout	1,590,000	29,957,100	269,300	31,816,400
Brook trout	874,000	2,951,000	10,937,100	14,762,100
Silver trout			232,700	232,700
Grayling		4,823,800		4,823,800
Pike and pickerel			465,800	465,800
Mackerel		2,067,000		2,067,000
Crappie			26,741,600	26,741,600
Largemouth black bass		919,300	1,394,500	2,313,800
Smallmouth black bass		810,000	161,700	971,700
Rock bass			66,100	66,100
Warmouth bass			4,900	4,900
Sunfish			27,746,700	27,746,700
Pike perch	82,745,000	130,960,000	27,200	213,732,200
Yellow perch	7,500,000	122,501,000	2,704,400	132,705,400
White bass			42,500	42,500
Sheepshead			300	300
Fresh-water drum			130,300	130,300
Cod	429,338,000	554,629,000		983,967,000
Haddock	114,051,000	31,895,000		145,946,000
Pollock		428,788,000		428,788,000
Winter flounder	53,735,000	2,334,322,000		2,388,057,000
Miscellaneous fishes			9,851,600	9,851,600
Total	737,136,100	4,195,942,200	299,294,700	5,232,373,000

Assignments of fish eggs to State and Territorial fish commissions, fiscal year 1926

State and species	Number
Arizona: Black-spotted trout	52,000
California: Black-spotted trout	354,000
Colorado: Loch Leven trout	336,000
Hawaii:	
Chinook salmon	15,000
Rainbow trout	25,000
Steelhead salmon	43,000
Idaho:	
Black-spotted trout	500,000
Rainbow trout	50,000
Illinois:	
Black-spotted trout	10,000
Lake trout	50,000
Loch Leven trout	25,000
Rainbow trout	51,800
Silver salmon	200,000
Iowa: Rainbow trout	51,300
Maine:	
Atlantic salmon	100,000
Lake trout	100,000
Maryland: Rainbow trout	104,000
Massachusetts:	
Loch Leven trout	100,000
Rainbow trout	25,000
Michigan: Cisco	8,000,000
Missouri: Loch Leven trout	100,000
Montana: Loch Leven trout	431,500
Nevada: Black-spotted trout	50,000
New Hampshire: Chinook salmon	75,000
New Mexico:	
Black-spotted trout	600,000
Loch Leven trout	500,000
New York:	
Black-spotted trout	15,000
Lake trout	515,000
New York—Continued.	
Steelhead salmon	25,000
North Carolina:	
Glut herring	25,000,000
Lake trout	50,000
Loch Leven trout	50,000
Rainbow trout	409,000
Oklahoma: Yellow perch	7,500,000
Oregon:	
Black-spotted trout	1,000,000
Chinook salmon	8,136,600
Steelhead salmon	510,000
Pennsylvania:	
Cisco	2,080,000
Loch Leven trout	500,000
Whitefish	5,470,000
South Dakota: Loch Leven trout	500,000
Utah:	
Black-spotted trout	100,000
Brook trout	274,000
Vermont:	
Lake trout	125,000
Steelhead salmon	100,000
Washington:	
Black-spotted trout	1,825,000
Humpback salmon	115,000
West Virginia: Loch Leven trout	150,000
Wyoming:	
Black-spotted trout	485,000
Lake trout	25,000
Loch Leven trout	300,000
Rainbow trout	250,000
Total	67,458,200

Shipments of fish and fish eggs to foreign countries, fiscal year 1926

Country and species	Number of eggs	Number of fish
Argentina: Top minnows		2,000
Brazil:		
Bream		100
Crappie		75
Rock bass		100
Canada: Loch Leven trout	852,000	
Colombia: Steelhead salmon	25,000	
Dominican Republic: Top minnows		15,000
Italy: Steelhead salmon	50,000	
Japan: Whitefish	2,700,000	
Switzerland: Rainbow trout	72,000	
Total	3,699,000	17,275

EGG COLLECTIONS

The degree of success attained in the collection of fish eggs depends largely upon the local conditions prevailing when the fish are spawning. If they are such that it is impossible for the commercial fishermen to set their nets or lift them at proper intervals, large numbers of eggs invariably are lost. Especially is this true with regard to operations with the commercial fishes of the Great Lakes. The various hatcheries on the Atlantic coast likewise are dependent upon the success of the commercial fishermen, though the catch is not influenced to a great extent by weather conditions. The market price of fish is a factor of considerable importance in the work of collecting eggs in this region. In the upper Mississippi Valley buffalo-fish eggs were collected from fish caught in the nets of commercial fishermen, and after being fertilized they were planted in suitable waters to be incubated under natural conditions.

Comparison of egg collections, fiscal years 1926 and 1925

Species	1926	1925	Species	1926	1925
Buffalo fish	128,100,000	140,400,000	Loch Leven trout	12,792,200	12,160,650
Carp	76,500,000	44,875,000	Brown trout	93,000	31,000
Shad	9,625,000	26,772,000	Lake trout	56,601,500	66,908,500
Glut herring	123,840,000	336,700,000	Brook trout	13,517,020	19,684,794
Whitefish	252,599,000	252,925,000	Grayling		917,000
Cisco	163,700,000	187,800,000	Mackerel	2,330,000	3,821,000
Chinook salmon	67,837,600	54,437,000	Pike perch	576,155,000	416,640,000
Chum salmon	18,860,000	17,110,000	Yellow perch	142,930,000	116,460,000
Humpback salmon	2,019,000		Cod	1,221,743,000	1,355,823,000
Silver salmon	8,520,000	11,578,000	Haddock	170,091,000	216,825,000
Sockeye salmon	59,481,490	64,465,000	Pollock	698,579,000	430,649,000
Steelhead salmon	6,473,600	4,174,969	Winter flounder	2,631,766,000	2,882,065,000
Landlocked salmon	923,450	1,263,000			
Rainbow trout	13,470,430	13,914,384	Total	6,478,453,290	6,705,428,297
Black-spotted trout	19,906,000	26,030,000			

FISH-RESCUE WORK

The State of Wisconsin has taken renewed interest in the salvage of food fishes along the western border of the Mississippi River, and in the prosecution of work in that field has greatly aided the bureau in covering the extensive territory where fish are stranded in land-locked pools. This State also has aided the bureau in distributing the salvaged fish, transporting them to their destinations in the State distribution car. Minnesota, Iowa, and Illinois also have engaged in independent rescue operations in the waters adjoining their boundaries. The territory covered by the States and the bureau has been equitably apportioned in order to avoid duplication of effort. Owing to low water stages no salvage work was undertaken during the year on the lower Mississippi River in the vicinity of Friars Point, Miss.

Number and disposition of fish rescued, fiscal year 1926

Locality and species	Delivered to applicants	Restored to original waters	Total number of fish rescued
Homer, Minn.:			
Black bass	33,811	117,463	151,274
Buffalo fish		139,870	139,870
Carp		3,795,915	3,795,915
Catfish	31,790	1,226,460	1,258,250
Crappie		3,795,915	3,795,915
Fresh-water drum		97,175	97,175
Pike and pickerel		154,630	154,630
Sunfish	217,400	10,592,700	10,810,100
White bass		13,105	13,105
Yellow perch	107,900	2,192,050	2,299,950
Miscellaneous		984,850	984,850
Total	561,511	29,033,508	29,595,019
La Crosse, Wis.:			
Black bass	4,035	25,195	29,230
Buffalo fish		1,079,500	1,079,500
Carp	160	9,034,840	9,035,000
Catfish	6,500	4,939,800	4,946,300
Crappie	10,485	2,505,515	2,516,000
Fresh-water drum		3,875	3,875
Pike and pickerel		235,700	235,700
Sunfish	40,500	2,762,500	2,803,000
White bass		18,890	18,890
Yellow perch	13,715	227,910	241,625
Miscellaneous		5,679,300	5,679,300
Total	75,395	26,513,025	26,588,420
Lynxville, Wis.:			
Black bass	15,573	36,382	51,955
Buffalo fish		551,700	551,700
Carp		10,701,000	10,701,000
Catfish	10,100	9,564,550	9,574,650
Crappie	53,410	4,296,890	4,350,300
Fresh-water drum		19,400	19,400
Pike and pickerel		9,490	9,490
Sunfish	79,825	4,675,175	4,755,000
White bass		9,625	9,625
Yellow perch	11,054	70,811	81,865
Miscellaneous	367	1,207,633	1,208,000
Total	170,329	31,142,656	31,312,985
Marquette, Iowa:			
Black bass	54,465	46,595	101,060
Buffalo fish		3,892,300	3,892,300
Carp		7,951,300	7,951,300
Catfish	30,200	12,298,800	12,329,000
Crappie		8,608,000	8,608,000
Fresh-water drum		4,700	4,700
Pike and pickerel		65,670	65,670
Rock bass	575		575
Sunfish		8,425,500	8,425,500
White bass		610	610
Yellow perch	375	78,705	79,080
Total	85,615	41,372,180	41,457,795

Number and disposition of fish rescued, fiscal year 1926—Continued

Locality and species	Delivered to applicants	Restored to original waters	Total number of fish rescued
Bellevue, Iowa:			
Black bass	1,280	1,395	2,675
Buffalo fish		5,156,100	5,156,100
Carp	200	7,647,800	7,648,000
Catfish	8,950	727,650	736,600
Crappie	9,240	56,535	65,775
Fresh-water drum		140	140
Pike and pickerel		280	280
Sunfish	15,570	54,910	70,480
White bass		225	225
Yellow perch	60	100	160
Miscellaneous	364	1,092,436	1,092,800
Total	35,664	14,737,571	14,773,235
Rock Island, Ill.:			
Black bass		1,195	1,195
Buffalo fish		430,500	430,500
Carp		1,218,000	1,218,000
Catfish		2,072,000	2,072,000
Crappie		1,292,000	1,292,000
Fresh-water drum		5,000	5,000
Sunfish		182,700	182,700
Miscellaneous		886,050	886,050
Total		6,087,445	6,087,445

STATIONS AND SUBSTATIONS AND OUTPUT OF EACH

During the fiscal year 1926 fish-cultural operations were conducted at 38 main stations and 32 substations, while fish eggs were secured in a number of collecting fields. The following table lists the stations in alphabetical order, each with its substations immediately following, and shows the output of fish and fish eggs from each point of operation.

Stations and substations operated and output of each, fiscal year 1926

[Asterisk (*) denotes transfer of eggs. See table, p. 339]

Stations, substations, and species	Eggs	Fry	Fingerlings, yearlings, and adults	Total [1]
Afognak, Alaska:				
Sockeye salmon			10,075,000	10,075,000
Steelhead salmon		850,000		850,000
Baird, Calif.: Chinook salmon			1,590,000	1,590,000
Battle Creek, Calif.: Chinook salmon	10,000		2,072,300	2,082,300
Mill Creek, Calif.: Chinook salmon	*15,000	800,000	1,665,400	2,480,400
Baker Lake, Wash.:				
Rainbow trout			4,000	4,000
Sockeye salmon		5,275,800	187,680	5,463,480
Birdsview, Wash.—				
Brook trout			17,000	17,000
Chinook salmon	(*)		826,000	826,000
Humpback salmon		305,000		305,000
Silver salmon	201,000	1,940,000	1,170,000	3,311,000
Sockeye salmon	150,000		26,500	176,500
Steelhead salmon	68,000		278,500	346,500
Duckabush, Wash.—				
Chinook salmon			328,750	328,750
Chum salmon		10,922,600		10,922,600
Humpback salmon		539,600		539,600
Silver salmon		780,300	206,900	987,200
Steelhead salmon			34,200	34,200
Quilcene, Wash.—				
Chinook salmon			351,050	351,050
Chum salmon		7,240,800		7,240,800
Silver salmon		1,207,500	246,500	1,454,000
Steelhead salmon		100,000	249,300	349,300

[1] Lost in transit, 47,828.

Stations and substations operated and output of each, fiscal year 1926—Continued

Stations, substations, and species	Eggs	Fry	Fingerlings, yearlings, and adults	Total
Baker Lake, Wash.—Continued.				
Sultan, Wash.—				
Chinook salmon	75,000		7,500	82,500
Silver salmon		628,000	584,000	1,212,000
Berkshire trout hatchery, Mass.:				
Brook trout			18,060	18,000
Rainbow trout			680	680
Smallmouth black bass			1,700	1,700
Boothbay Harbor, Me.: Winter flounder		1,487,528,000		1,487,528,000
Bozeman, Mont.:				
Black-spotted trout	550,000	200,000	226,500	976,500
Brook trout		18,000	627,000	645,000
Landlocked salmon			6,000	6,000
Loch Leven trout	*1,399,500		1,876,070	3,275,570
Rainbow trout			592,750	592,750
Glacier Park, Mont.—				
Black-spotted trout	350,000	388,200	415,000	1,153,200
Grayling		1,195,000		1,195,000
Rainbow trout			517,000	517,000
Meadow Creek, Mont.—				
Black-spotted trout	350,000	760,000		1,110,000
Grayling		3,628,800		3,628,800
Loch Leven trout	*2,470,000	488,000		2,958,000
Rainbow trout	*168,000	897,000		1,065,000
Brook trout		18,000		18,000
Cape Vincent, N. Y.:				
Largemouth black bass		50,000	13,200	63,200
Brook trout		176,000	275,900	451,900
Cisco	*10,080,000	84,800,000		94,880,000
Lake trout		1,664,000	7,500	1,671,500
Loch Leven trout		46,000		46,000
Rainbow trout		64,000	40,000	104,000
Smallmouth black bass		39,000	2,200	41,200
Whitefish	910,000	39,200,000		40,110,000
Swanton, Vt.—				
Largemouth black bass			30	30
Pike perch	*58,245,000	24,750,000		82,995,000
Yellow perch		17,290,000		17,290,000
Central Station, Washington, D. C.:				
Largemouth black bass			270	270
Brook trout			33,150	33,150
Crappie			75	75
Cisco		200,000		200,000
Pike perch		600,000		600,000
Rainbow trout			14,700	14,700
Rock bass			250	250
Sunfish			200	200
Whitefish		800,000		800,000
Bryans Point, Md.—				
Largemouth black bass			50	50
Shad		9,143,750		9,143,750
Yellow perch		96,121,000	380	96,121,380
Lakeland, Md.—				
Largemouth black bass			7,690	7,690
Crappie			3,920	3,920
Sand perch			5,000	5,000
Smallmouth black bass			50	50
Sunfish			2,820	2,820
Clackamas, Oreg.:				
Brook trout			79,200	79,200
Chinook salmon	(*)		5,750,000	5,750,000
Silver trout			21,500	21,500
Steelhead salmon	75,000		59,000	134,000
Applegate, Oreg.—				
Silver salmon			717,600	717,600
Steelhead salmon	*925,000		2,530,200	3,455,200
Big White Salmon, Wash.—				
Chinook salmon	*1,555,640		7,600,000	9,155,640
Steelhead salmon		20,000	99,800	119,800
Little White Salmon, Wash.—				
Brook trout			163,300	163,300
Chinook salmon	*9,026,000		14,733,000	23,759,000
Steelhead salmon			140,020	140,020
Rogue River, Oreg.—				
Brook trout			24,100	24,100
Chinook salmon			1,370,000	1,370,000
Silver salmon	10,000		1,946,400	1,956,400
Silver trout			44,000	44,000
Sockeye salmon			20,000	20,000
Steelhead salmon	*60,000		707,000	767,000

Stations and substations operated and output of each, fiscal year 1926—Continued

Stations, substations, and species	Eggs	Fry	Fingerlings, yearlings, and adults	Total
Clackamas, Oreg.—Continued.				
Salmon, Idaho—				
Chinook salmon			10,970,000	10,970,000
Rainbow trout			134,800	134,800
Steelhead salmon			79,000	79,000
Wind River, Wash.—Chinook salmon	* 603,000		3,560,000	4,163,000
Cold Springs, Ga.:				
Large mouth black bass		227,300	60,730	288,030
Catfish			6,820	6,820
Sunfish			156,500	156,500
Craig Brook, Me.:				
Atlantic salmon	100,000	776,000	125,600	1,001,600
Brook trout	(*)	494,100	405,400	899,500
Humpback salmon		908,900	90,000	998,900
Landlocked salmon	* 60,000	146,000	131,650	337,650
Grand Lake Stream, Me.—				
Brook trout		161,000		161,000
Landlocked salmon	323,900	268,500	132,400	724,800
Duluth, Minn.:				
Brook trout			129,600	129,600
Lake trout	* 25,000	9,663,000	129,000	9,817,000
Pike perch		16,290,000		16,290,000
Whitefish		1,400,000		1,400,000
Edenton, N. C.:				
Largemouth black bass		10,500	102,950	113,450
Catfish			300	300
Crappie			1,630	1,630
Glut herring		55,000,000		55,000,000
Sunfish			13,700	13,700
Warmouth bass			150	150
Yellow perch		1,500,000		1,500,000
Erwin, Tenn.:				
Largemouth black bass		3,500	68,170	71,670
Brook trout			283,200	283,200
Catfish			2,100	2,100
Crappie			440	440
Rainbow trout	131,640		132,560	264,200
Rock bass			25,020	25,020
Sunfish			21,200	21,200
Yellow perch			200	200
Fairport, Iowa:				
Largemouth black bass			4,970	4,970
Buffalo fish			3,640	8,640
Carp			300	300
Catfish			2,650	2,650
Crappie			2,470	2,470
Sheepshead			270	270
Sunfish			76,890	76,890
Gloucester, Mass.:				
Cod	*379,857,000	403,008,000		782,865,000
Haddock	114,051,000	31,895,000		145,946,000
Pollock		428,788,000		428,788,000
Winter flounder		135,841,000		135,841,000
Homer, Minn.:				
Largemouth black bass			151,270	151,270
Buffalo fish			139,870	139,870
Carp			3,795,900	3,795,900
Catfish			1,258,250	1,258,250
Crappie			9,889,900	9,889,900
Fresh-water drum			97,170	97,170
Pike and pickerel			154,630	154,630
Sunfish			10,810,100	10,810,100
White bass			13,100	13,100
Yellow perch			2,299,900	2,299,900
Miscellaneous			984,850	984,850
La Crosse, Wis.:				
Largemouth black bass			68,230	68,230
Buffalo fish			1,079,500	1,079,500
Brook trout			542,300	542,300
Carp			9,035,000	9,035,000
Catfish			4,946,300	4,946,000
Crappie			2,516,000	2,516,000
Fresh-water drum			3,880	3,880
Loch Leven trout			126,220	126,220
Pike and pickerel			235,700	235,700
Pike perch			27,200	27,200
Rainbow trout			166,500	166,500
Sunfish			2,803,000	2,803,000
White bass			18,890	18,890
Yellow perch			241,620	241,620
Miscellaneous			5,679,300	5,679,300

Stations and substations operated and output of each, fiscal year 1926—Continued

Stations, substations, and species	Eggs	Fry	Fingerlings, yearlings, and adults	Total
La Crosse, Wis.—Continued.				
Atchafalaya, La.: Buffalo fish		105,315,000		105,315,000
Bellevue, Iowa:				
Largemouth black bass			2,670	2,670
Buffalo fish			5,156,100	5,156,100
Carp			7,648,000	7,648,000
Catfish			736,600	736,600
Crappie			65,770	65,770
Fresh-water drum			140	140
Pike and pickerel			280	280
Sunfish			70,480	70,480
White bass			220	220
Yellow perch			160	160
Miscellaneous			1,092,800	1,092,800
Lynxville, Wis.:				
Largemouth black bass			51,950	51,950
Buffalo fish			551,700	551,700
Carp			10,701,000	10,701,000
Catfish			9,574,650	9,574,650
Crappie			4,350,300	4,350,300
Fresh-water drum			19,400	19,400
Pike and pickerel			9,490	9,490
Sunfish			4,755,000	4,755,000
White bass			9,620	9,620
Yellow perch			81,860	81,860
Miscellaneous			1,208,000	1,208,000
Marquette, Iowa:				
Largemouth black bass			101,060	101,060
Buffalo fish			3,892,300	3,892,300
Carp			7,951,300	7,951,300
Catfish			12,329,000	12,329,000
Crappie			8,608,000	8,608,000
Fresh-water drum			4,700	4,700
Pike and pickerel			65,670	65,670
Rock bass			580	580
Sunfish			8,425,500	8,425,500
White bass			610	610
Yellow perch			79,080	79,080
Miscellaneous			570	570
Rock Island, Ill.:				
Largemouth black bass			1,200	1,200
Buffalo fish			430,500	430,500
Carp			1,218,000	1,218,000
Catfish			2,072,000	2,072,000
Crappie			1,292,000	1,292,000
Fresh-water drum			5,000	5,000
Sunfish			182,700	182,700
Miscellaneous			886,000	886,000
Yellowstone, Wyo.: Black-spotted trout	*7,667,800	125,000	2,847,000	10,639,800
Leadville, Colo.:				
Black-spotted trout			326,500	326,500
Brook trout	*600,000		3,373,900	3,973,900
Lake trout			71,000	71,000
Loch Leven trout			134,000	134,000
Rainbow trout			143,000	143,000
Steelhead salmon			37,000	37,000
Louisville, Ky.:				
Largemouth black bass			1,900	1,900
Catfish			400	400
Lake trout		14,500		14,500
Rock bass			950	950
Smallmouth black bass		525,000	5,070	530,070
Sunfish			23,300	23,300
Mammoth Spring, Ark.:				
Largemouth black bass			80,300	80,300
Catfish			1,070	1,070
Crappie			500	500
Rock bass			15,600	15,600
Smallmouth black bass			121,000	121,000
Sunfish			45,000	45,000
Manchester, Iowa:				
Brook trout			208,400	208,400
Loch Leven trout			49,000	49,000
Rainbow trout	(*)		85,450	85,450
Nashua, N. H.:				
Brook trout		100,500	479,300	579,800
Landlocked salmon			500	500
Loch Leven trout			3,340	3,340
Rainbow trout			56,400	56,400

Stations and substations operated and output of each, fiscal year 1926—Continued

Stations, substations, and species	Eggs	Fry	Fingerlings, yearlings, and adults	Total
Neosho, Mo.:				
Largemouth black bass			33,040	33,040
Catfish			14,850	14,850
Crappie			3,800	3,800
Loch Leven trout			30,000	30,000
Rainbow trout	*718,515		131,885	850,400
Rock bass			4,240	4,240
Sunfish			27,800	27,800
Yellow perch			100	100
Bourbon, Mo.: Rainbow trout	583,200		14,000	597,200
Langdon, Kans.—				
Largemouth black bass			48,380	48,380
Catfish			13,700	13,700
Crappie			7,640	7,640
Rock bass			650	650
Sunfish			7,630	7,630
Yellow perch			1,000	1,000
Northville, Mich.:				
Largemouth black bass			600	600
Brook trout		644,500	205,050	849,550
Rainbow trout		102,500	47,600	150,100
Smallmouth black bass		214,000	30,100	244,100
Sunfish			3,800	3,800
Alpena, Mich.—				
Lake trout	25,000	1,659,000	60,000	1,744,000
Whitefish	150,000	19,000,000		19,150,000
Charlevoix, Mich.—				
Chub		1,400,000		1,400,000
Lake trout	*1,540,000	16,900,000		18,440,000
Steelhead salmon		26,500		26,500
Whitefish		21,700,000		21,700,000
Orangeburg, S. C.:				
Largemouth black bass			51,520	51,520
Catfish			30	30
Crappie			680	680
Sunfish			40,400	40,400
Warmouth bass			2,060	2,060
Put in Bay, Ohio:				
Carp		54,500,000		54,500,000
Pike perch	24,500,000	89,320,000		113,820,000
Smallmouth black bass			550	550
Whitefish	*7,260,000	117,924,000		125,184,000
Yellow perch	*7,500,000	7,590,000		15,090,000
Quinault, Wash.:				
Black-spotted trout			30,000	30,000
Chinook salmon			13,300	13,300
Silver salmon			263,500	263,500
Silver trout			167,150	167,150
Sockeye salmon	(*)	4,520,000	6,765,000	11,285,000
Steelhead salmon			105,000	105,000
St. Johnsbury, Vt.:				
Brook trout		1,178,374	390	1,178,764
Lake trout		56,600		56,600
Landlocked salmon		17,500		17,500
Loch Leven trout		82,000		82,000
Steelhead salmon		18,000		18,000
Holden, Vt.: Lake trout			1,800	1,800
York Pond, Vt.: Brook trout		160,560	680	161,240
San Marcos, Tex.:				
Largemouth black bass			346,100	346,100
Catfish			5,600	5,600
Crappie			230	230
Rock bass			5,580	5,580
Sunfish			64,890	64,890
Warmouth bass			1,620	1,620
Medina Lake, Tex.—				
Largemouth black bass			19,880	19,880
Rainbow trout			5,000	5,000
Steelhead salmon			5,500	5,500
New Braunfels, Tex.—				
Largemouth black bass			61,300	61,300
Sunfish			5,800	5,800
Saratoga, Wyo.:				
Brook trout			603,500	603,500
Loch Leven trout	25,000		278,630	303,630
Rainbow trout	*950,000	477,240	57,000	1,484,240
Spearfish, S. Dak.:				
Brook trout			[2] 1,293,750	1,293,750
Loch Leven trout			205,250	205,250
Rainbow trout			124,500	124,500

[2] In addition to 291,570 fingerling trout turned over to the State of South Dakota in cooperative work.

Stations and substations operated and output of each, fiscal year 1926—Continued

Stations, substations, and species	Eggs	Fry	Fingerlings, yearlings, and adults	Total
Springville, Utah:				
Black-spotted trout			37,200	37,200
Brook trout	*274,000		512,450	786,450
Catfish			100	100
Rainbow trout	72,000		494,770	566,770
Tupelo, Miss.:				
Largemouth black bass		362,500	73,230	435,730
Crappie			150	150
Sunfish			200,150	200,150
Warmouth bass			1,050	1,050
White Sulphur Springs, W. Va.:				
Largemouth black bass			38,800	38,800
Brook trout			[3] 1,445,800	1,445,800
Crappie			4	4
Loch Leven trout			281,700	281,700
Rainbow trout	*204,150		724,560	928,710
Rock bass			8,400	8,400
Smallmouth black bass			420	420
Woods Hole, Mass.:				
Cod	49,481,000	151,621,000		201,102,000
Mackerel		2,067,000		2,067,000
Steelhead salmon	5,820	15,000		20,820
Winter flounder	53,735,000	710,953,000		764,688,000
Wytheville, Va.:				
Largemouth black bass		265,500	9,820	275,320
Brook trout			220,750	220,750
Loch Leven trout			2,800	2,800
Rainbow trout	(*)		152,250	152,250
Rock bass			5,160	5,160
Smallmouth black bass		32,000	600	32,600
Sunfish			13,200	13,200
Yes Bay, Alaska: Sockeye salmon			47,606,800	47,606,800

[3] In addition to 625,000 fingerling brook trout turned over to the State of West Virginia in cooperative work.

TRANSFERS OF EGGS BETWEEN STATIONS

Large numbers of fish eggs are transferred annually between various stations of the bureau, such action being taken in the interest of economy and for convenience in distributing the product.

Transfer of eggs between stations, fiscal year 1926

Species	Number of eggs	From—	To—
Black-spotted trout	150,000	Yellowstone Park, Wyo	Clackamas, Oreg.
	255,000	do	Leadville, Colo.
	50,000	do	Do.
	175,000	do	Seattle, Wash.
	21,000	do	Holden, Vt.
	300,000	do	Saratoga, Wyo.
	200,000	do	Clackamas, Oreg.
Brook trout	175,000	Craig Brook, Me	Grand Lake Stream, Me.
	400,000	Leadville, Colo	Northville, Mich.
	350,000	do	Bozeman, Mont.
	726,000	Springville, Utah	Do.
	502,400	do	White Sulphur Springs, W. Va.
	283,000	do	Bozeman, Mont.
Chinook salmon	600,000	Mill Creek, Calif	Battle Creek, Calif.
	120,000	do	Baird, Calif.
	20,000	Clackamas, Oreg	Central Station, Washington, D. C.
	525,000	Big White Salmon, Wash	Clackamas, Oreg.
	672,000	Little White Salmon, Wash	Birdsview, Wash.
	672,000	do	Quilcene, Wash.
	3,479,000	do	Wind River, Wash.
	520,000	do	Clackamas, Oreg.
	500,000	Salmon, Idaho	Little White Salmon, Wash.
	824,200	Upper Clackamas, Oreg	Clackamas, Oreg.
	852,000	do	Do.
	1,280,000	Wind River, Wash	Do.

Transfer of eggs between stations, fiscal year 1926—Continued

Species	Number of eggs	From—	To—
Cisco	1,280,000	Cape Vincent, N. Y.	Central Station, Washington, D. C.
Cod	2,083,000	Gloucester, Mass.	Woods Hole, Mass.
Lake trout	30,000	Duluth, Minn.	Leadville, Colo.
	15,000	do	Louisville, Ky.
	1,000,000	Charlevoix, Mich.	Cape Vincent, N. Y.
	50,000	do	Holden, Vt.
Landlocked salmon	15,000	Craig Brook, Me.	Nashua, N. H.
	25,000	do	St. Johnsbury, Vt.
Loch Leven trout	156,000	Bozeman, Mont.	Do.
	150,000	do	La Crosse, Wis.
	50,000	Meadow Creek, Mont.	Neosho, Mo.
	50,000	do	Cape Vincent, N. Y.
	164,000	do	Leadville, Colo.
	150,000	do	White Sulphur Springs, W. Va.
	100,000	do	Manchester, Iowa.
	375,000	do	Bozeman, Mont.
	25,000	do	Nashua, N. H.
Pike perch	800,000	Swanton, Vt.	Central Station, Washington, D. C.
	200,000	do	Erwin, Tenn.
Rainbow trout	25,000	Meadow Creek, Mont.	Manchester, Iowa.
	50,000	do	Wytheville, Va.
	25,000	do	Holden, Vt.
	624,000	do	Bozeman, Mont.
	405,520	do	Glacier Park, Mont.
	50,000	do	Berkshire trout hatchery, Mass.
	100,000	Clackamas, Oreg.	Salmon, Idaho.
	50,000	Wytheville, Va.	Meadow Creek, Mont.
	121,330	Neosho, Mo.	La Crosse, Wis.
	91,740	do	Do.
	50,000	Saratoga, Wyo.	Leadville, Colo.
	153,000	Lost Creek, Wyo.	Saratoga, Wyo.
Sockeye salmon	25,000	Quinault, Wash.	Rogue River, Oreg.
	150,000	do	Birdsview, Wash.
	5,621,000	Yes Bay, Alaska	Baker Lake, Wash.
Steelhead salmon	125,000	Applegate, Oreg.	Clackamas, Oreg.
	50,000	do	Holden, Vt.
	50,000	do	Little White Salmon, Wash.
	250,000	do	Quinault, Wash.
	25,000	Rogue River, Oreg.	Charlevoix, Mich.
	25,000	do	Woods Hole. Mass.
	50,000	do	St. Johnsbury, Vt.
Whitefish	800,000	Put in Bay, Ohio	Central Station, Washington, D. C.
Yellow perch	6,000,000	do	Mammoth Springs, Ark.

EGG COLLECTING AT AUXILIARY STATIONS

In many instances the eggs incubated at the main hatcheries are obtained from substations located at points more or less remote. It is not always possible to operate substations for a long period, and frequently the eggs must be transferred in the green state. In other cases it is convenient to hold them at the point of collection until they are eyed. On account of the additional cost involved in operating substations, they are usually closed as soon as possible and all eggs transferred to the main stations. The following table shows the egg-collecting fields, the stations under which they are operated, the species handled, and the period of operation:

Egg-collecting stations

Station	Period of operation	Species handled
Boothbay Harbor, Me.:		
Casco Bay, Me	Mar. 2-Apr. 30	Winter flounder.
Ebenecook Harbor, Me	do	Do.
Friendship Harbor, Me	do	Do.
Georges Island Harbor, Me	do	Do.
Johns Bay, Me	do	Do.
Linekins Bay, Me	do	Do.
Mill Cove, Me	do	Do.
Pig Cove, Me	do	Do.
Muscongus Sound, Me	do	Do.
Port Clyde Harbor, Me	do	Do.
Sheepscot River, Me	do	Do.
Townsend Gut, Me	do	Do.
Bozeman, Mont.: Mystic Lake, Mont	May 11-June 30	Rainbow and Black-spotted trout.
Cape Vincent, N. Y.:		
Bath, Ontario	Oct. 29-Nov. 15	Whitefish.
Brighton, Ontario	Oct. 28-Nov. 15	Do.
Chaumont Bay, N. Y	Nov. 3-Nov. 29	Do.
Do	Nov. 16-Dec. 1	Cisco.
Fair Haven Bay, N. Y	do	Do.
Cobourg, Ontario	Oct. 28-Nov. 12	Whitefish.
Port Hope, Ontario	do	Do.
Pigeon Island, Ontario	Oct. 13-Nov. 1	Lake trout.
Simco Island, Ontario	Nov. 3-Nov. 29	Do.
Stony Island, N. Y	Oct. 17-Nov. 3	Do.
Bowmanville, Ontario	Oct. 28-Nov. 12	Whitefish.
Wellers Bay, Ontario	Nov. 12-Nov. 20	Cisco.
Clackamas, Oreg.:		
Upper Clackamas, Oreg	Aug. 15-Oct. 15	Chinook salmon.
Lemhi River, Idaho	Aug. 15-Sept. 10	Do.
Pahsimeroi River, Idaho	Apr. 1-June 1	Steelhead salmon.
Craig Brook, Me.:		
Craig Pond, Me	Oct. 29-Nov. 15	Brook trout.
Dennysville, Me	Sept. 1-Sept. 30	Humpback salmon.
Toddy Pond, Me	Oct. 25-Nov. 15	Landlocked salmon.
Duluth, Minn.:		
Bemidji, Minn	Apr. 17-May 12	Pike perch.
Big Traverse Bay, Mich	Oct. 17-Nov. 2	Lake trout.
Copper Harbor, Mich	Sept. 28-Oct. 17	Do.
Gay, Mich	Oct. 17-Oct. 29	Do.
Grand Marais, Mich	Oct. 17-Nov. 2	Do.
Huron Island, Mich	Oct. 17-Nov. 1	Do.
Isle Royale, Mich	Sept. 30-Nov. 15	Lake trout and whitefish.
Keystone, Mich	Oct. 17-Oct. 24	Lake trout.
Manitou Island, Mich	Oct. 17-Oct. 30	Do.
Marquette, Mich	Oct. 17-Nov. 3	Do.
Munising, Mich	do	Do.
Do	Nov. 15-Nov. 28	Whitefish.
Ontonagon, Mich	Oct. 17-Nov. 5	Lake trout.
Portage Entry, Mich	Oct. 17-Nov. 1	Do.
Portage Lake Canal, Mich	do	Do.
Gloucester, Mass.:		
Ipswich Bay, Mass	November to May	Cod and haddock.
Marblehead, Mass	February and March	Cod.
Plymouth, Mass	November to May	Cod and pollock.
Rockport, Mass	do	Cod, pollock, and haddock.
Leadville, Colo.:		
Baker Lake, Colo	May 3-May 20	Rainbow trout.
Bolts Lake, Colo	Apr. 19-May 10	Do.
Englebrechts Lakes, Colo	Sept. 25-Nov. 24	Brook trout.
Mount Massive Club Lakes, Colo	Oct. 21-Dec. 1	Do.
Turquoise Lake, Colo	Oct. 19-Dec. 15	Do.
Wurts Lakes, Colo	Oct. 7-Nov. 9	Do.
Northville, Mich.:		
Big Reef, Mich	Nov. 2-Nov. 27	Lake trout and whitefish.
Black River, Mich	Nov. 4-Nov. 11	Do.
Ossineke, Mich	Oct. 30-Nov. 9	Do.
Manistique, Mich	Nov. 4-Nov. 20	Do.
Naubinway, Mich	Nov. 6-Nov. 20	Do.
Cheboygan, Mich	Oct. 23-Nov. 5	Lake trout.
Presque Isle, Mich	Oct. 28-Oct. 30	Do.
Rockport, Mich	Oct. 30-Nov. 7	Do.
St. Ignace, Mich	Oct. 23-Oct. 30	Do.
Northport, Mich	Nov. 10-Nov. 20	Do.
Leland, Mich	do	Do.
Fairport, Mich	Nov. 4-Nov. 20	Do.
Epoufette, Mich	Nov. 9-Nov. 16	Whitefish.
Hammonds Bay, Mich	Nov. 16	Do.
Gould City, Mich	Nov. 8-Nov. 20	Do.
Cross Village, Mich	Nov. 9-Nov. 19	Do.

Egg-collecting stations—Continued

Station	Period of operation	Species handled
Put In Bay, Ohio:		
Port Clinton, Ohio	Nov. 3–Nov. 30	Whitefish.
Do	Apr. 12–May 10	Pike perch and yellow perch.
Do	June 3–June 29	Carp.
Toledo, Ohio	Nov. 3–Nov. 30	Whitefish.
Do	Apr. 12–May 10	Pike perch.
Catawba Island, Ohio	Nov. 3–Nov. 27	Whitefish.
North Bass, Ohio	Nov. 3–Nov. 29	Do.
Do	Apr. 15–May 1	Pike perch.
Middle Bass, Ohio	do	Do.
Do	Nov. 4–Nov. 28	Whitefish.
St. Johnsbury, Vt.: Lake Dunmore, Vt.	Oct. 5–Nov. 3	Lake trout.
Saratoga, Wyo.:		
Big Creek Lakes, Wyo	Sept. 21–Nov. 10	Brook trout.
Lost, Sage, and Canon Creeks	Mar. 24–June 25	Rainbow trout.
Springville, Utah:		
Fish Lake, Utah	Mar. 22–May 31	Do.
Do	Oct. 28–Dec. 9	Brook trout.
Strawberry Reservoir	May 25–June 20	Black-spotted trout.
Woods Hole, Mass.: Wauquoit, Mass	Jan. 15–Mar. 30	Winter flounder.

HATCHERY FISH-CULTURAL NOTES

SHIPMENT OF EYED FISH EGGS BY THE BULK METHOD

The following item is extracted from the annual report of the superintendent of the White Sulphur Springs (W. Va.) station:

The use of the bulk method for shipping eggs that are overdeveloped, even to the slightest extent, invariably results in some indentation of the eggs; and where such a condition exists an abnormal loss is inevitable, not only during the incubation period but among the sac-stage fry. Firm advocates of the bulk method doubtless will rejoin that overdeveloped eggs should never be shipped. While admitting the truth of this contention, it is, nevertheless, not always possible to ship eggs at exactly the right stage of development, and for this and other reasons the tray method of shipment is considered preferable. If the ice hopper is kept well filled with ice and the package is maintained at the proper temperature en route, there can not be the slightest question on arrival at destination as to the condition of eggs shipped by the tray method.

TRANSPORTATION OF BROOD WINTER FLOUNDER

The superintendent of the Woods Hole (Mass.) station reports on an innovation in the method of shipping brood winter flounder from the fields where captured to the hatchery. He states:

In the transportation of the adult fish this season the conventional transportation can was abandoned entirely. In its place a large basket was used with much success. The fish were placed flat on the bottoms of the baskets, which previously had been covered with seaweed or moss. A light covering of the same material was then placed over them, and in very cold weather the baskets were covered with blankets as a further protection against frost. By this method we find less mortality and, more important, there appeared to be fewer fish with the so-called "hardened" eggs.

WATERTOWN (N. Y.) REARING STATION

Owing to lack of a suitable water supply for the production of fingerling fish at the Cape Vincent (N. Y.) station, it has been necessary heretofore to distribute the entire output of young trout in the fry stage, much to the dissatisfaction of local applicants. Under such conditions the need of a rearing center in northern New York has long been apparent, and a recent opportunity offered to engage in cooperative trout rearing with the Jefferson County

(N. Y.) Fish and Game Association at Watertown, N. Y., was taken advantage of promptly. The project controlled by the organization was fitted to receive an adequate water supply from a small spring-fed creek, and 80 rearing troughs of standard size were installed, half of them being the property of the association. The bureau supplies the young fish for stocking the project and furnishes the services of an experienced man to care for them. As a result of the first season's cooperative work at this point 287,000 trout 2 inches and over in length were produced and distributed to applicants.

EXPERIMENTAL FEEDING OF BROOD TROUT

The Wytheville (Va.) station is conducting an experiment for the purpose of determining the comparative value of various fish foods in egg production. With this in view, the 3-year-old brood stock at the station has been divided into two equal lots, one of which is fed solely on beef heart and the other on sheep liver. An equal division also has been made of the 4-year-old fish, one lot being fed on beef heart and the other on sheep liver and mush. When concluded, the results of this experiment should prove valuable in connection with future trout-cultural operations.

SHAD HATCHING IN GEORGIA WATERS

With the view of determining the value of the Ogeechee River as a shad-hatching center, experimental shad propagation was undertaken at Savannah, Ga., by the State authorities in the spring of 1926. Under the direction of the superintendent of the bureau's Warm Springs station, whose services were loaned for the purpose, a boat belonging to the State was outfitted to serve as a floating hatchery and placed in readiness to assume the work on April 1. A careful search maintained throughout the spawning period failed to disclose the presence of any shad in spawning condition until near the end of April, at which time 250,000 ripe eggs were collected, fertilized, and incubated with only a slight loss. This represented the only tangible result of the undertaking.

COMMERCIAL FISHES

The more important commercial fishes propagated by the bureau during the fiscal year 1926 were the salmons of the Pacific coast, the lake trout, whitefish, cisco, and pike perch of the Great Lakes region, the cod, haddock, pollock, mackerel, and flounder of the New England coast, the shad and river herring of Atlantic coastal streams, and the buffalo fish of the Mississippi River region. Carp in considerable numbers also were produced in connection with the work on Lake Erie.

PACIFIC SALMONS

Fish-cultural operations at the 6 main stations and 15 substations coming under this head were directed almost exclusively to the propagation of salmon. The aggregate egg collections of the group for the year shows a substantial increase as compared with last year's figures. This was due partly to the resumption of propagation work at the Afognak (Alaska) station and partly to the very successful work accomplished in the Oregon field.

Afognak (Alaska) Station

[Frank L. Snipes, Superintendent]

After a lapse of two years, for the purpose of making a tally of the run of salmon into the waters of the Afognak region, preparations for the resumption of active fish-cultural work in the propagation of sockeye salmon were undertaken with the opening of the fiscal year 1926. The run of this species into Letnik Lake during the season was again small, as compared with the large runs in years past. Only 5,544 fish were counted. This does not represent the total escapement, however, as during a period of high water a slight shifting of the rack allowed a considerable number to pass underneath, and these, together with the counted salmon, were estimated to amount to approximately 11,000. Egg collections began on August 3, and between that time and the middle of September 4,400 female fish were spawned, yielding 11,000,000 eggs of fine quality. Comparatively large numbers of silver and humpback salmon were in evidence, but as the counting weir was closed on August 15 they could not enter Letnik Lake and were forced to spawn in the river below.

During the winter of 1925–26 the weather was so mild that, with the exception of a few days in early December, all of the lakes and streams of the region remained open almost throughout the year.

With the intention of transferring the resulting spawn to the Washington stations, 2,060,000 steelhead-salmon eggs were taken during the last half of April from brood fish that enter the lake. After 1,023,000 eyed eggs had been forwarded to Seattle for distribution, such a marked rise occurred in the water temperature that it was impossible to ship the remaining eggs. They were therefore incubated and the resulting fry deposited on the native spawning grounds. On May 20, 1926, the first sockeye salmon of the season entered the lake, and by the end of June more than 18,000 had passed through the counting weir. The indications for a successful season in 1927 were therefore encouraging.

Yes Bay (Alaska) Station

[J. L. Gardner, Superintendent]

With the opening of the fiscal year 1926 approximately 20,000,000 fingerling sockeye salmon were on hand at this station. These were liberated during the months of July, August, and October in Lake McDonald. In anticipation of the fishing season the seining grounds were cleared of débris, the seining beaches extended 80 feet, and on July 20 and 21 racks and traps were erected. Shortly after this time a run of humpback salmon occurred, but no sockeyes were in evidence until considerably later. Fishing for sockeye salmon began on September 7 and was continued up to October 6, the season's collection of eggs of this species amounting to 39,680,000. While their quality as a whole appeared to be very good, the lateness of the run necessitated the handling of large numbers of green fish, and this, together with a shortage of male fish, resulted in a considerable number of unfertilized eggs. Some losses also were experienced from uneven development of the eggs in the hatchery, the eggs thus affected evidently being from diseased fish. The water during the eying period was much warmer than usual and a considerable amount of fungus developed on the eggs, involving much additional labor in caring for them. The results of incubation were fairly good, notwithstanding these handicaps, and more than 89 per cent of the entire collection hatched. The water was very low during the entire fishing season, and toward the end it became necessary to seine in the lake, the water in the river being too low to permit the ascent of the fish. At least 5,000,000 eggs were deposited naturally between the rack site and the lake in the course of the spawning period.

The use of ponds in connection with the liberation of young salmon has proved to be a decided success. The fingerling fish are placed in the ponds and allowed to pass into the lake at will, being fed at regular intervals as long as they remain in the ponds. By this means the fish gradually become accustomed to their freedom and are in much better condition than when planted direct from the troughs.

Baker Lake (Wash.) Station and Substations

[Joseph Kemmerich, Superintendent]

Fish-cultural operations were in progress in this field throughout the year at the main station and five of its auxiliaries, while eggs from the late run of chum salmon were obtained at a sixth auxiliary, at Brinnon, Wash. While weather and water conditions during the spawning season were largely unfavorable and undoubtedly occasioned some falling off in egg collections, the major part of the heavy decrease shown—the total of 26,273,000 eggs secured being little more than half as large as the collection of the preceding year—is ascribed to the altered conditions brought about through the construction of a hydroelectric dam in Baker River near the town of Concrete. Aside from the eggs collected, eggs of the sockeye, chinook, silver, and humpback salmons aggregating 10,615,000 were received from other sources and handled at Baker Lake or some of its auxiliaries.

Baker Lake (Wash.) station.—Fish-cultural operations at this station, so far as the collection of eggs is concerned, were almost a complete failure due to the erection of the dam at Concrete, Wash. The entire brood stock of sockeye salmon secured for the season consisted of the 40 fish that passed through the obstruction when the diversion channel was open during the first days of July. On July 8 the channel was closed, forcing all water through three flood gates; and from that time on the immense volume of rapidly flowing water, with the 7-foot drop at the lower end, constituted an impassable barrier to the passage of fish. Several attempts were made during the season to improvise a fishway, but they were not successful. On July 10 it was noted that brood sockeyes were congregating below the dam in considerable numbers, and the run was estimated to consist of not less than 10,000 fish. This large body of salmon remained below the structure struggling persistently in their vain efforts to surmount it, until, completely exhausted, they gradually disappeared. A large number perished in the Baker and Skagit Rivers, and by the middle of September only a very few were left. The run of chinook and silver salmon dropped back into the Skagit River, finding other suitable spawning grounds; but from all evidence obtainable there was nothing to show that any of the sockeyes deposited their spawn, and it is believed the run of that species in Baker River was a complete loss. Fifty thousand eggs were obtained from the few brood fish referred to above, and about 5,621,000 eyed eggs were transferred from the Yes Bay (Alaska) station, these two lots forming the entire stock of sockeye-salmon eggs handled in the course of the season.

Birdsview (Wash.) substation.—On account of its low water level during the spawning season of the chinook and humpback salmons no eggs from either of these species were obtainable from Grandy Creek. In an effort to locate other sources of supply all streams tributary to the Skagit River within a reasonable distance were inspected, and it was found that the waters at the mouths of most of them were spreading over a wide area and were too shallow to permit the entrance of fish. This situation was remedied so far as possible by the station employees, who spent several days in deepening and narrowing the channels so that salmon could pass through them and continue their upward journey. Eyed eggs of chinook salmon to the number of 672,000 were received from the Little White Salmon hatchery, and by means of a trap made of chicken wire enough brood fish of this species were taken in Phinney Creek late in September to yield 53,000 additional eggs. Six hundred and forty thousand fingerling silver salmon, carried over from the stock of the preceding year, were liberated early in July in tributaries of the Skagit River. Eggs of this species to the number of 2,833,000 were taken between October 30 and February 8, of which 200,000 were shipped in the eyed stage to the Lincoln Park aquarium at Chicago, Ill. The remainder was hatched and the fry liberated in due season in tributaries of the Skagit River. From 205 ripe female humpback salmon taken in a temporary trap installed in Phinney Creek 335,000 eggs were collected. These were developed with only a small loss and the product returned as advanced fry to the parent stream. About 308,000 steelhead salmon carried over from last year's stock were utilized in filling applications or planted in suitable local waters. Notwithstanding its very low water stages during most of the spring, the run of this species into Grandy Creek was the largest of any year since 1918. Between March 17 and June 4, 855,000 eggs were obtained, and had the creek been at its usual spring stage this collection probably could have been doubled. Among other shipments of

eyed eggs taken from this lot one consignment of 43,000 was sent to Hawaii. Owing to inability to forward the shipment when the eggs were at the most suitable stage of development, it was feared that the loss would be heavy. However, the eggs were reported as arriving at destination in good condition and with a loss of only 200 in transit.

Duckabush (Wash.) substation.—As the formation of the Duckabush River near its mouth is not suitable for the erection of a permanent trap, a temporary trap was built just above the Olympic highway bridge instead of under it, as was the case last year. The first of the early-run chum salmon appeared late in August, and from September 5 to October 1 eggs were taken almost daily, the total amounting to 9,000,000. As soon as the early run was over the temporary trap was removed and stored because of the danger from floods. No late-run chum salmon ascended the river as far as the location of the permanent trap, but eggs from that run were obtained at Walcotts Slough, near Brinnon, Wash., where employees of the Duckabush and Quilcene substations cooperated in collecting eggs. However, there was no room for any eggs from that source in the Duckabush hatchery, which was already filled to capacity with spawn from the early run, hence the entire collection was incubated at Quilcene. The usual run of silver salmon ascended the river during the fall and winter, but as the permanent trap was completely submerged on several occasions nearly all the fish passed upstream to spawn. The local collections, extending from November 17 to February 24, amounted to 320,000 eggs taken from 105 female fish. These, with the 750,000 eyed eggs of the same species received from one of the Washington State hatcheries, were incubated, and the resulting fry and fingerling fish were liberated in the Duckabush River. The first humpback salmon of the season appeared at the temporary trap late in August, and between September 2 and October 1, 550,000 eggs were taken from the 332 female fish secured. On account of the low water stage in the river at this time, many humpback salmon spawned in the salt water near its mouth.

In continuation of past efforts to establish a run of chinook salmon in the Duckabush River, 328,000 fingerlings, the product of a shipment of 336,000 eyed eggs of that species, were liberated in the river during the spring of 1926. As was the case during the run of silver salmon, the greater part of the steelhead salmon ascending the river during the spring passed over the permanent trap during high water stages. A few fish were taken, but most of them were too immature to be retained in pens, and only 19 were in spawning condition. From this stock 81,700 eggs were taken during the period from March 24 to May 1.

Quilcene (Wash.) substation.—In advance of the fall spawning season, a new and permanent trap, built exceptionally strong to withstand flood waters, was constructed in the Big Quilcene River on the site formerly occupied by the old trap. In anticipation of the early run of chum salmon, traps also were installed near the mouths of the Big Quilcene and Little Quilcene Rivers. Owing to the prevailing low water stage in these streams, egg collections were considerably below normal. The first of the early-run fish appeared at the temporary traps late in August; the first ripe eggs were taken on September 6, and from that date to October 6 spawning operations were conducted almost daily, 1,180,000 eggs being taken at the Big Quilcene trap and 365,000 at the other location. Almost all eggs of this species from the late run were taken at the Walcotts Slough trap near Brinnon, Wash., where collecting operations were in progress from December 1 to January 13, and 5,635,000 eggs obtained.

Early in November 336,000 eyed chinook-salmon eggs were received from the Little White Salmon hatchery. These were incubated and the resulting fry deposited in the Big Quilcene River in furtherance of an attempt to establish a run of the species in this region. Owing to the prevalence of low water in the Big Quilcene River during the greater part of the silver-salmon spawning season, the collection of eggs of that species was considerably below the total of last year. Between December 1 and February 8, 790,000 eggs were taken, and early in February 750,000 additional eggs, in the eyed state, were received from the State of Washington. The low water level prevented the collection of any humpback-salmon eggs, but on November 20, 2,000,000 eyed eggs of that species were received from the Washington fisheries authorities with the understanding that the resulting fry, in the sac stage, would be returned to be reared in a salt-water pond owned by the State in the vicinity of Quilcene.

Through the carelessness of two of the station employees, the water supply was shut off from some of the hatching troughs, during the night of February 3, and 1,100,000 fry were lost.

A portion of the stock of 338,000 steelhead-salmon fry and fingerlings on hand at the opening of the fiscal year was distributed to applicants, and the remainder was liberated in local public waters. Because of an unusually low river level, the collection of steelhead eggs, during the spring of 1926, was the smallest in the past several years, the total amounting to only 62,000. These were taken between March 5 and April 28.

Ozette (Wash.) substation.—A counting weir has been maintained in the Ozette River for the past two years, primarily for the purpose of determining to what extent sockeye salmon run into Ozette Lake. Operations at the weir having demonstrated that sockeye, silver, and steelhead salmon enter the lake in sufficient numbers to warrant the establishment of a hatchery, the next essential step was to ascertain as to the possibility of holding brood sockeye salmon from the time they run into the lake, late in May, until they are in spawning condition in October. With this end in view a survey of the Ozette watershed was made, and two locations apparently well suited to penning operations were selected, one on Ozette River, and one in Umbrella Creek.

The Ozette River inclosure, constructed on the site of the former counting weir, is of sufficient size to impound more than 1,000 fish. The Umbrella Creek inclosure was formed by building two racks about 300 feet apart, with a holding capacity for 5,000 fish.

In the early part of June, about 1,300 fish were placed in the Ozette River inclosure, but with the rising water temperature, late in that month, fungus began developing on the fish to such an extent that it became necessary to liberate them in the lake. It is intended to confine all fish caught after July 1 in the Umbrella Creek inclosure.

Sultan (Wash.) substation.—Elwell Creek, upon which this substation depends for its supplies of chinook and humpback salmon eggs, was virtually dry during most of the spawning season and remained in that condition until late October, when the humpback run was over and only a few partly spawned-out chinook salmon were available. By means of a gaff hook a sufficient number of these partially spent fish were taken near the mouth of the creek to yield 99,000 eggs. Silver-salmon eggs were collected at this point from October 25 to January 5, the total for the season amounting to 1,383,000. On January 5 Elwell Creek rose to the highest stage ever recorded, overflowing its banks and washing out a channel that finally undermined the east shore crib of the rack and completely destroyed it. This brought the silver-salmon work to an end, and as the trap could not be repaired in time for the steelhead-salmon run no eggs of that species were collected.

Quinault (Wash.) Station

[Marcus S. Meyer, Superintendent]

The daily count of sockeye salmon passing through the weir into the upper Quinault River was in progress during the first 10 days in July. The total count for the season, which began on March 19, amounted to 19,395, or about 117,000 less than the count of the previous year. In view of a recent decision by the Federal Court at Tacoma, Wash., giving the local Indians the privilege of fishing at any point on the Quinault Reservation, the bureau considered it advisable to discontinue counting operations with the close of the season.

Fish-cultural operations at this station are concerned principally with the propagation of the sockeye salmon. During the spawning season, which extended from November 2 to December 16, 2,000,000 eggs were collected in the upper Quinault River, 5,770,000 in Big Creek, 630,000 in Merriman Creek, and 80,000 in Falls Creek, the aggregate of 8,480,000 being only about two-thirds of the total number secured last year. With the exception of 175,000 eyed eggs (shipped to other stations of the bureau) and the 800,000 fingerlings on hand at the end of June, all of the young fish resulting from the collections were liberated in Quinault River and its tributaries, as were also the 5,000,000 fingerlings on hand at the beginning of the year. The eggs taken in Big Creek in past years have been conveyed to the hatchery by canoe. During the past season all collections from this source were transported by means of the station truck, thereby obviating the necessity of daily transporting the canoe to the creek.

In the absence of the counting weir, no steelhead-salmon eggs were collected during the spring, and work with that species was confined to the incubation of 250,000 eyed eggs transferred from the Applegate Creek substation, the product of which was on hand at the close of June. Small numbers of eggs of the silver and chinook salmon, taken in connection with the sockeye-salmon collections, were incubated and the fry reared to the fingerling stage before planting. The silver trout resulting from a consignment of eggs donated by the State of Washington in the previous fiscal year were distributed as yearlings. Before liberating them the right ventral and adipose fins were removed, the object in marking them being to determine if they would eventually return from salt water as larger sized fish than those that have passed their entire existence in fresh waters.

Clackamas (Oreg.) Station and Substations

[Philo B. Hawley, Superintendent]

Grouped under this head are the main station at Clackamas and its seven auxiliaries situated in Oregon, Washington, and Idaho, five of them being in operation throughout the year. Fish-cultural work consisted in the propagation of the chinook, silver, and steelhead salmons, approximately 67,000,000 eggs of which species were collected, or about 16,000,000 in excess of last year's total. In the course of the year the Oregon Fish and Game Commission rendered valuable aid not only in furnishing eggs for incubation but in giving financial assistance, thus enabling the bureau to carry out its program of producing a large number of fingerling fish for distribution.

Clackamas (Oreg.) station.—The year's fish-cultural activities at this point were initiated in August by the erection of a head rack across the Clackamas River. Owing to abnormally low water stages very disappointing results were attained in fishing for chinook salmon (conducted from September 27 to October 26), and the total number of eggs collected amounted to only 1,701,000, showing a shortage of about 50 per cent, as compared with the work of last year. All eggs were of good quality, however, and the loss during incubation was merely nominal. In the course of the year small numbers of eyed eggs of the brook trout and rainbow trout were received and incubated, and from the steelhead eggs received from auxiliaries of the Clackamas station two shipments, in the eyed stage, were forwarded to foreign countries—one to Columbia and one to Italy.

Upper Clackamas (Oreg.) substation.—Fishing for chinook salmon was in progress from August 28 to September 19, and during this time 1,721,500 eggs were secured. As no facilities for the rearing of young salmon are available at this substation, the entire collection was transferred in the eyed stage to the Clackamas station, and the substation was closed for the season.

Little White Salmon (Wash.) substation.—The stock of young brook trout and steelhead salmon on hand at the beginning of the year (about 166,000) was held for a time and then distributed to applicants or planted in suitable public waters. In August racks and traps were built in the Little White Salmon River. By September 14 chinook salmon began to appear, and on August 20 spawning operations were undertaken and conducted continuously to October 7. Eggs to the number of 29,484,000 were secured, and many millions more might have been taken had enough hatching room been available. Of these eggs 10,890,000 were shipped in the eyed stage, part of them to the Oregon Fish and Game Commission and the remainder to other hatcheries of the bureau. In the course of the year this substation received 105,000 brook-trout eggs from the Clackamas station and 50,000 steelhead eggs from the Applegate Creek substation. The resulting fry were distributed to applicants of the region.

Big White Salmon (Wash.) substation.—Work at this point was wholly on the propagation of chinook-salmon eggs, supplies of which are obtained from the Big White Salmon River and Spring Creek. Traps were erected in each of these streams early in September, and by September 10 a few brood fish had entered the Spring Creek ladder. Active spawning operations were undertaken on September 19, and between that date and October 9, 12,259,000 eggs were collected, of which about 7,000,000 were derived from Spring Creek. An important feature of the work on Spring Creek is that until within a very few years ago the run of chinook salmon in this stream was negligible. On reaching the eyed stage, 1,500,000 of the eggs were transferred to the Oregon Fish

and Game Commission and 525,000 were consigned to the Clackamas station. The fry hatched from the remaining stock were reared to the fingerling size and then liberated on local spawning grounds.

Rogue River (Oreg.) substation.—The stock of about 576,000 young brook trout, silver trout, and steelhead salmon on hand at the opening of the year was distributed later, a large percentage being deposited in the Rogue River. All natural conditions being favorable, the work of erecting the head rack on Rogue River was accomplished in June of the preceding year. On August 15 the collection of chinook-salmon eggs was begun, and between that time and the end of September 1,594,000 eggs were secured. In anticipation of the run of silver and steelhead salmon in Big Butte Creek and Elk Creek, racks and traps were built immediately after the close of the chinook spawning season, and from November 2 to January 8, 2,159,000 silver-salmon eggs were obtained, the collection being about 50 per cent larger than last year's. Due to prolonged drought and consequent low-water stages in Rogue River during the spring, the collection of steelhead-salmon eggs was disappointing, only 436,900 being secured, a little more than half the number obtained in 1925. The Oregon game commission lent one of its large trucks for making the distribution of the resulting fry, thus greatly facilitating the work.

Applegate Creek (Oreg.) substation.—The steelhead salmon on hand at the beginning of the fiscal year were liberated during July as No. 2½ fingerlings. Silver-salmon operations at this point were seriously affected by an unusually low water level in Applegate Creek, which remained at its ordinary summer stage during most of the spawning season. As the result of a slight rise in the late fall, 735,000 eggs were secured from November 16 to December 29. Shortly after the first of February a decided rise in water level in the creek induced the entrance of a comparatively large run of steelhead salmon, but continuous rains caused the stream to become so swollen that many of the fish escaped over the dam. Between February 18 and April 28, 2,864,000 eggs were collected. On attaining the eyed stage 1,500,000 were distributed to applicants and other stations of the bureau.

Salmon (Idaho) substation.—The stock of fish on hand at the beginning of the year was distributed to applicants in July. With the view of intercepting all chinook salmon entering the Lemhi River, racks were built early in May of the preceding year, and during July fish in considerable numbers were in evidence. Spawning operations began on August 17, and eggs were taken regularly from that date to September 4, the yield being 12,000,000, one of the largest collections ever made in the region. The run of salmon in the Pahsimeroi River proved negligible, and the racks and traps which had been erected on that stream early in the fiscal year were removed in September. An attempt made in cooperation with the Idaho Fish and Game Commission to collect steelhead-salmon eggs in the Pahsimeroi River proved disappointing, only 114,000 being secured. Two consignments of rainbow-trout eggs aggregating 350,000 were received during May and June, one from the State of Idaho and one from the main station at Clackamas, Oreg.

Wind River (Wash.) substation.—Fish-cultural activities at this substation (formerly operated by the State of Washington) were experimental in character, being undertaken with the view of determining the feasibility of conducting permanent work in this field. Chinook-salmon spawning operations were in progress from September 19 to October 7, resulting in the collection of 2,298,000 eggs. This total being considerably smaller than the holding capacity of the hatchery, 3,749,000 additional green eggs were transferred from the Little White Salmon hatchery for incubation. Upon development to the eyed stage, shipments aggregating 1,883,000 eggs were forwarded to the Clackamas station and to the Oregon game commission. The fry hatched from the remaining eggs were liberated in Wind River, and on February 1 the substation was closed. Heretofore logging operations have made the entrance of salmon into this stream very difficult; now that such work is virtually at an end there is a prospect that future fish-cultural operations may be followed by satisfactory results.

Baird (Calif.) Station and Substations

[W. K. Hancock, Superintendent]

The outcome of the year's work in the propagation of chinook salmon in the California field was quite encouraging, the total number of eggs collected being approximately 2,300,000 greater than in 1925 and slightly more than the total in 1924. These results were accomplished despite the fact that conditions were unfavorable, the water in the McCloud River being polluted from the middle of June to the 1st of September with a thick yellow volcanic ash from Mount Shasta.

Baird (Calif.) station.—Though traps were installed in the upper racks in the McCloud River early in the season, it is believed that a large number of the earlier run salmon passed up the river during the time repairs were being made to the 75-foot section of the upper rack mentioned in last year's report as having been washed away. Owing to the cloudiness of the water it was impossible to determine whether the racks were tight or what was the condition of the fish in the retaining pools. Seining operations were taken up on September 1 and conducted almost every evening from 7 to 10 o'clock between that date and September 4, by which time all of the early-run fish had disappeared. Brood female salmon were plentiful, but a serious shortage of male fish made it difficult to fertilize all eggs secured. A total of 1,530,000 eggs of excellent quality resulted from the season's work, this number exceeding the annual average of the past 12 years by a few thousand. As only a few of the fall run salmon enter the McCloud River, no effort was made to collect eggs from that run. On account of the prevailing low water stage in the gravity ditch a battery of troughs was set up outside the hatchery and fed from the spring until the eggs commenced to hatch, when they were transferred to the hatchery and water was pumped from the river until February 4. At that time the occurrence of heavy rains and high water made it possible to use the gravity supply. During a high water stage in February virtually all of the lower rack cribs were washed out and the upper crib was damaged considerably.

Battle Creek (Calif.) substation.—The usual arrangements for the collection of the chinook salmon eggs were taken up about September 1, at which time a crew of men was engaged to erect racks and traps and put the fishing equipment in condition for service. Owing to the low water level very unsatisfactory results were attained in seining in Battle Creek, and fishing operations soon were extended to the Sacramento River. While this involved additional labor in moving the fishing equipment, it was more than justified by the results, the total egg collections being approximately twice as large as last year.

Mill Creek (Calif.) substation.—During the latter part of August, while the creek was virtually dry, arrangements were made to set up the racks, and on November 3 fishing operations were undertaken. Between November 3 and December 4, 3,270,000 eggs of the finest quality were collected, as compared with last year's total of 2,200,000. Owing to lack of fry-holding space, 120,000 of the eyed eggs were transferred to Baird station and 600,000 to Battle Creek with the object of planting the resulting fry in waters near those stations. The remainder were hatched at the point of collection, and the product was liberated in Mill Creek as fingerling fish.

FISHES OF THE GREAT LAKES

This group consists of four main stations, four substations, and a large number of collecting auxiliaries situated along the shores of the Great Lakes, the range of operations extending from Rainy Lake, Minn., to the Vermont waters of Lake Champlain. Particular attention is paid to the propagation of such commercial fishes as the lake trout, whitefish, cisco, and pike perch, though considerable numbers of eggs of other species are hatched annually at the stations of this class and are distributed to applicants. Unfavorable weather predominated during the lake trout and whitefish spawning seasons in many of the collecting fields, materially reducing the egg collections.

Duluth (Minn.) Station

[S. P. Wires, Superintendent]

Early in the fall the usual arrangements were made for the collection of lake trout and whitefish spawn in the Michigan waters of Lake Superior. The collection of lake-trout eggs commenced September 30 at various points on Isle Royale and Copper Harbor and continued until the beginning of the State closed season, which extended from October 9 to October 16. The work was resumed on the 17th and was prosecuted successfully during the succeeding three days, the catch of trout along the south shore of Lake Superior between Ontonagon and Grand Marais being very heavy at this time. During October 19, however, heavy winds and generally unfavorable weather set in and continued almost without interruption up to the close of the spawning period on November 15. The season's collection as a whole were very light From the total of 15,757,000 lake-trout eggs secured 10,262,000 eyed eggs, fry, and fingerling fish were developed and supplied to applicants or planted in suitable public waters. The only whitefish eggs handled were 2,320,000 that were secured by commercial fishermen operating at Isle Royale and Munising, Mich., in connection with the collection of lake-trout spawn. This stock yielded 1,400,000 fry, all of which were returned to spawning grounds in Lake Michigan waters.

Additional funds enabled this station to cooperate with the Minnesota fisheries authorities in the propagation of pike perch at the Bemidji (Minn.) State hatchery. During the spawning season—extending from April 16 to May 4—570 quarts of eggs were collected. These were cared for in the Bemidji hatchery until far enough advanced to bear transportation, when they were divided in proportion to the amount expended by each party. The bureau's share, amounting to 16,380,000 eggs, was transferred to the Duluth hatchery, and after the completion of incubation the fry were distributed to applicants. The losses on the eggs and fry during the period they were held were very light. The funds expended by the bureau for this work were applied to operating expenses only, as the State furnished all nets, boats, and other equipment and made no charge for the necessary water, fuel, or light.

The year's work at this station included the handling of 200,000 eyed brook-trout eggs received during the winter from a commercial dealer in Pennsylvania. From this stock 129,000 fry were hatched and reared to the No. 1 fingerling stage, at which time they were distributed to applicants.

Northville (Mich.) Station and Substations

[W. W. Thayer, Superintendent]

The fishes propagated at the Northville station during the year included the brook trout and rainbow trout, smallmouth black bass, and bream (*Lepomis pallidus*). During the month of January 1,157,000 eyed brook-trout eggs, most of them of fair quality, were received from various sources, some by purchase from commercial firms and the remainder through exchange. The eggs were incubated with only a small loss, but there was a heavy mortality among the resulting fry in May, due to sudden and extreme temperature changes. A large proportion of the young fish hatched from this stock was distributed to applicants in Ohio and Indiana, while comparatively small numbers were forwarded to the cooperative rearing projects at Turtle Lake and Rose City, Mich. A consignment of 150,000 rainbow-trout eggs, received during the spring from the State hatchery at Paris, Mich., was incubated, and the resulting fry were distributed with only a slight loss.

The stock of smallmouth-bass fry on hand at the opening of the fiscal year yielded more than 12,000 fingerling fish for later distribution. Of 285 adult bass of this species placed in their winter holding quarters late in the fall of 1925 only 79 were found when the pond was drained in the spring. There being no other apparent reason for this loss, it could only be concluded that the fish were stolen. At once 209 additional brood bass were obtained from Lake Erie waters and apportioned in the breeding ponds with the survivors of the original stock. Excellent weather and water conditions prevailed throughout the spawning season, and at the end of June the indications were that the yield of fry would be approximately twice that of the preceding year. Only a small brood stock of bream is held at this station, hence the output of that fish is never large.

Alpena (Mich.) substation.—Extensive improvements were made to the hatchery buildings and grounds at this station in the summer of 1925, chief among them being the excavation of a basement under the hatchery, laying cement floors in the basement and hatching room, and the installation of a 282-jar whitefish battery in the hatchery. As only a comparatively small amount of commercial fishing for lake trout was conducted in surrounding fields, a large take of eggs of that species was not anticipated. Severe storms also played an important part in reducing the collections, many of the fishermen's nets being torn to shreds, while the hauling of the nets at regular intervals was prevented by high winds. The earliest eggs were taken in the Cheboygan field on October 24, and the last were secured at Big Reef on December 21, the total for the season amounting to 3,634,500. From November 2 to November 19, 23,300,000 whitefiesh eggs were obtained from the various fields. The quality of the spawn of both species was somewhat above the average, and a good percentage of hatch was realized.

Charlevoix (Mich.) substation.—Though the work of obtaining whitefish and lake-trout eggs for stocking the Charlevoix hatchery was greatly obstructed by high winds, which prevailed almost to the end of the spawning season, the collections of eggs of both species were somewhat larger than last year. All of the spawn was much better than the average in quality. This is accounted for by the greater care exercised in fertilizing the eggs and by the application of improved methods in handling the hatchery work. The earliest lake-trout eggs of the season were taken October 23, at St. Ignace, Mich., and 36,000,000 were taken between that time and November 20. The collection of whitefish eggs began on November 6 and ended November 20, the total amounting to 27,000,000. Steelhead-salmon eggs to the number of 27,500, received during the spring from one of the bureau's stations in Oregon, were incubated with good results.

Put in Bay (Ohio) Station

[David Davies, Superintendent]

Arrangements for the collection of whitefish eggs at the various collecting points on Lake Erie were made early in November, and on the 3d of that month all necessary collecting equipment was distributed among the commercial fishermen, who were cautioned to exercise the utmost care in handling and fertilizing the eggs taken. The first lot of eggs was received at the hatchery on November 4, the season opening several days earlier than was the case during the past few years. The severe storms and generally unfavorable weather that predominated virtually throughout the egg-collecting period seriously interfered with the lifting of the fishermen's nets at regular intervals, and as a result the collection of eggs was not so large as had been expected, though it exceeded that of the previous year by approximately 1,400,000 eggs. Several million eyed eggs were furnished the Pennsylvania fish commission, and a consignment of 2,700,000 was forwarded to the Japanese Government.

The first pike-perch eggs of the season arrived at the station on April 22, the spawning season opening unusually late. For several years past the brood female pike taken for the work at this station have been quite small in size, but last year a great many were from 6 to 12 pounds in weight. The egg collection was large, being about double that of the preceding year, but the quality was very poor, less than 25 per cent producing fry. The last eggs of the season were secured on May 11.

A somewhat smaller collection of yellow-perch eggs was made than in 1925, the total amounting to 21,700,000. Of this number 6,000,000 were shipped to the Mammoth Spring (Ark.) station and 7,500,000 were furnished the Oklahoma fish commission. The remainder were hatched at the station in wire baskets suspended in water, the estimated percentage of hatch being about 92.

Early in June a temporary hatching battery for the propagation of carp was installed in one of the commercial fish houses in the Port Clinton (Ohio) field, and the work of collecting eggs, which extended from June 6 to June 24, was quite successful, 76,000,000, or approximately 100 per cent more than the total of either of the two preceding years, being obtained. With the exception of 1,000,000 fry that were placed in a pond near Sandusky Bay the entire product of the eggs collected was liberated in the Portage River several miles above Port Clinton.

Cape Vincent (N. Y.) Station and Substation

[Jno. P. Snyder, Superintendent]

Permission having been obtained from the Ontario fisheries department to collect lake-trout eggs in the vicinity of Pigeon and Simcoe Islands, in Canadian waters of Lake Ontario, active operations in those fields were undertaken on October 13. Under a permit issued by the New York conservation commission collections also were made in the vicinity of Grenadier and Stony Islands in the New York waters of the lake. Brood fish were present in the usual numbers in all these fields, but they were soon driven from the bars into deeper water by heavier wind storms, making the operating season very short. In taking trout at Grenadier Island, a locally constructed net, somewhat different from the ordinary type, was used successfully. The majority of the trout captured in all fields were either green or spent, and virtually all of the 1,100,000 eggs obtained were taken from fish caught in the evening hauls. This stock was augmented later by the transfer of 1,000,000 eyed eggs from the Charlevoix (Mich.) field.

The bureau was not permitted by the Ontario authorities to collect whitefish spawn in the Bay of Quinte and South Bay, but it was allowed to occupy fields in Wellers Bay, near Brighton, Port Hope, Cobourg, Bowmanville, and Port Whitney, Ontario, where commercial fishing is conducted on a comparatively limited scale and principally in the open waters of the lake. At the outset a large run of whitefish was in evidence at all points covered, but the favorable prospects soon were dissipated by a heavy wind storm that swept the lake with great violence, destroying or carrying away most of the fishermen's nets; and after its subsidence, more than a week later, it was found that almost all whitefish had disappeared. The effects of the storm on the New York side of the lake were very destructive also, with the single exception of Chaumont Bay, which is partly sheltered, and in this field 24,000,000 eggs (more than half the season's collection at all points) were secured. Eggs of the cisco (lake herring) were taken between November 12 and December 1, the collections aggregating 163,760,000 eggs. A noteworthy feature of the propagation of this species is that it seems to be increasing rapidly in the eastern end of Lake Ontario, while the supply in the western end of the lake apparently has undergone a material diminution. Until quite recently cisco were seen rarely in the St. Lawrence River; they are now found there in large numbers, especially within the past two years. Some 20 miles below the lake many are being taken with hook and line.

Late in December 270,000 eyed brook-trout eggs were purchased from a commercial dealer and 500,000 were received from the Pennsylvania fish commission. Fifty thousand Loch Leven trout eggs were furnished from the Meadow Creek (Mont.) field, and 160,000 rainbow-trout eggs were sent to the station by the Michigan department of conservation in return for eggs of other species. The majority of the fry derived from this stock were transferred to the Watertown (N. Y.) field station to be reared to the fingerling stage before distribution. The remaining fry were shipped to applicants soon after they were hatched.

In pursuance of a cooperative agreement 100 brood bass were supplied in advance of the 1925 spawning season for stocking Redfield Pond near Rutland, Vt., controlled by the Rutland County Fish and Game Association. During the succeeding July 89,000 bass fry of the largemouth and smallmouth species were taken from this pond for distribution, and later in the season an additional 15,425 bass in the fingerling No. 2½ stage were collected from the inclosure and used for stocking other waters.

Swanton (Vt.) substation.—Early in the fiscal year, quite extensive repairs to the station buildings and equipment were made. An arrangement was effected with the Pennsylvania fish commission whereby that organization defrayed the expense of tearing out the old pens used for holding fish and reconstructing them with new material. All of the buildings were put in good repair and painted two coats; one new live car for towing fish from the seining grounds to the pens was provided; several seine windlasses were constructed and a new seining ground cleared and made ready for operations.

The cooperative agreement in force during the past few years with the States of Pennsylvania and Vermont was renewed and everything was made ready to begin active fish-cultural work on April 1. The weather at that time was cold, however, and the lake was still covered with ice. It being evident on April 16 that the fish had commenced their annual migration up the

Missisquoi River, seining under the ice in quest of a brood stock was at once undertaken and continued as conditions permitted until April 22, when further work of that character was rendered dangerous owing to the softening of the ice. During this period, 2,272 brood-pike perch were taken, transferred to the hatchery, and placed in retaining pens. With the general breaking up of the ice on April 27, seining was resumed and continued to May 5, though it was evident that the majority of the fish had already passed into the river and some were returning, as spent fish. The brood stock acquired numbered 4,440, of which 2,880 were females. From this source an aggregate of 117,653,000 eggs was taken, and one-half of them were transferred to the Pleasant Mount State hatchery of the Pennsylvania fish commission. One million eyed eggs of the bureau's share were forwarded to the Erwin (Tenn.) station and to Central Station, Washington, D. C. The fry resulting from the rest were distributed to applicants and planted in suitable places in Lake Champlain. From 18,400,000 eyed yellow-perch eggs collected in the march adjoining the Swanton hatchery early in May, approximately 17,000,000 fry were hatched. Some of these were distributed to applicants and some were returned to parent waters.

Bryans Point (Md.) Substation

[L. G. Harron, Superintendent]

The year's work in the propagation of shad in this field is discussed on page 358 under the heading "Anadromous fishes of the Atlantic Coast." Operations connected with the preparation of the hatchery and its equipment for active fish-cultural work were undertaken on March 1. The work of procuring adult yellow perch from commercial fishermen of the region to serve as a brood stock was taken up on March 3 and prosecuted vigorously up to March 20, resulting in the acquirement of about 23,400 fish. In accordance with the usual method, these fish spawned in live cars anchored in Accokeek Creek, and 101,180,000 eggs were collected therefrom between March 24 and April 7. All of the resulting fry were liberated on the principal spawning grounds of the species in tributaries of the Potomac River. The light yield of eggs from the large brood stock on hand is attributed to the small size of the fish, the average length of the females being less than 7½ inches.

RESCUE OPERATIONS

La Crosse (Wis.) Station and Substations

[C. F. Culler, in charge]

Early in the fiscal year the central directing base for fish-rescue operations was transferred from Homer, Minn., to La Crosse, Wis., where a new hatchery, 84½ by 53¾ feet, was constructed. On the first floor of the building is a large hatching room, offices, and an aquarium for the exhibition of the fishes of the region, while storage rooms and dormitories for the use of the station employees are fitted up on the second floor. A garage, 30 feet by 36 feet, for housing the bureau's trucks, also was erected.

The rescue territory covered during the year extended from Reeds Landing, Minn., to a point about 14 miles below Bellevue, Iowa, and from Rock Island, Ill., to Montpelier, Ill. During the operation season which opened early in July and continued until late in November, 149,814,899 fish were salvaged, the cost of the work amounting to approximately 14⅕ cents per thousand. In adition to the rescue work, considerable numbers of eggs of the brook, rainbow, and Loch Leven trout are handled at this station annually. During the year cooperative agreements were entered into with the owners of several trout ponds in the vicinity of La Crosse for the collection of brook-trout eggs, and from one pond as many as 310,000 eggs were obtained. Due to lack of vitality, however, this lot was a total loss. A smaller number of eggs, secured at another point, were incubated with a loss of only 6 per cent. Late in December a consignment of 750,000 brook-trout eggs, forwarded by a commercial dealer in Pennsylvania, was found on arrival at the station to be badly frozen, and about 396,000 dead eggs were removed in the first picking. These dead eggs were replaced later by the shipment of another lot, but the fry developed from the second consignment were small and the losses abnormal. A shipment of 500,000 brook-trout eggs forwarded from a commercial hatchery in Colorado in exchange for eggs of other species apparently was in good condition on

arrival, but the fry hatched from them were afflicted with a disease known as "blue sac," and nearly all of them perished. Other shipments of brook, rainbow, and Loch Leven trout eggs were received in fine condition, and the resulting fry were strong and healthy.

Homer (Minn.) substation.—Fish-cultural operations at this station consist almost exclusively in the rescue of landlocked fishes from overflowed lands along the Mississippi River and the inoculation of considerable numbers of them with the larvæ of the commercial mussels. Game fishes also are held here for later distribution, the station having pond capacity for about 2½ carloads. During the early part of the rescue season the water level in the river was at a favorable point, but it receded later, and had it not been for frequent rains many of the pools would have become dry before the fish contained in them could be salvaged. Work was prosecuted under such conditions until October, when the operations were considerably checked by cold weather and heavy rains.

Bellevue (Iowa) substation.—Notwithstanding the fact that the water level at this point was not favorable for rescue work and only one crew of men was employed, the season's results were very satisfactory, the number of fish salvaged being 100 per cent larger than in the preceding year.

Marquette (Iowa) substation.—Rescue work at this substation is prosecuted in connection with similar operations conducted at Guttenberg, Iowa. The field is advantageously located for the distribution of fish, and its output compares very favorably with that at other collecting points.

Atchafalaya (La.) substation.—Because of the large amount of pollution carried in the water from Ouachita River, which supply was used at the hatchery site formerly occupied in the propagation of buffalo fish in the Louisiana field, the old location was abandoned and a new hatchery erected during the year on the Bayou Plaquemine, where a water supply of good quality is accessible. The material for the new hatchery, which is 20 feet by 75 feet in dimensions, was provided by the Louisiana Conservation Commission, while the work of constructing it was done by the bureau's force in connection with their regular fish-cultural duties. During the spawning season of the buffalo fish (from February 26 to April 1) 128,100,000 eggs of fine quality were obtained. These were incubated successfully and produced 105,315,000 fry, which were planted on the native spawning grounds.

Mussel Infection in Conjunction with the Rescue of Landlocked Fishes

Mussel-infection operations were conducted as heretofore in connection with the salvage of food fishes from overflowed lands along the Mississippi River. The work assumed extensive proportions and resulted in the release of 2,803,653,100 larval mussels on the gills of suitable fishes, at an average cost of only $0.00144 per thousand. Much valuable cooperative assistance was rendered by clam fishermen and others engaged in the industry, while many letters commending the work were received from clam and pearl dealers and pearl-button manufacturers. The fields in which mussel-infection operations were conducted during the year and the numbers and species of mussels handled in each are shown in the following table:

Summary of mussel-infection work, fiscal year 1926

Stations	Species		
	Grass mucket (*L. luteola*)	River mucket (*L. ligamentina*)	Pocketbook (*L. ventricosa*)[1]
Wabasha, Minn.	21,790,000	9,459,000	
Alma, Wis.	1,468,000	10,508,300	
West Newton, Minn.		18,339,000	
Minneiska, Minn.		94,022,800	
Chimney Rock, Wis.	31,576,900		
Winona, Minn.	741,153,000		
Homer, Minn.	305,608,500	372,219,900	2,290,000
Dakota, Minn.		9,582,000	
La Crosse, Wis.	429,009,000		
Genoa, Wis.	14,569,000	131,531,500	36,665,000
Ferryville, Wis.	12,840,000	5,339,500	
Lynxville, Wis.	109,015,000	197,986,000	
Marquette, Iowa		8,404,500	
Guttenburg, Iowa		48,978,000	
North Buena Vista, Iowa		3,560,500	
Bellevue, Iowa	12,987,600	21,720,100	
Andalusia, Ill.		153,002,000	
Total	1,680,017,000	1,084,653,100	38,955,000

[1] This mussel is not of best quality, and fishes are infected with it only when first-class mussels are not available.

MARINE FISHES

Although the combined egg collections at the stations comprising this group did not reach the enormous total attained in 1925, they were well above the average collections of past years and the results of the fiscal year's work may be regarded as fairly successful. Eggs of the various species handled to the number of 4,571,098,000 were taken at the three stations, showing a falling off of 315,000,000 when compared with the total of the preceding year. This loss was occasioned principally by the smaller collections of winter-flounder eggs made along the Maine coast. In addition to the total named, 153,148,000 cod and haddock eggs were secured in connection with the offshore fishing operations and were planted as fertilized eggs on the grounds where taken.

Boothbay Harbor (Me.) Station

[E. E. Hahn, Superintendent]

Although a very careful watch was maintained in the hope that pollock, haddock, and cod in spawning condition might be secured, no eggs of any of those species were obtained, and the year's work at this station was confined to the propagation of the winter flounder or flatfish. Active operations for the collection of eggs of this species were undertaken on March 2, when the entire 88 fyke nets available for the work were set in desirable positions from west Penobscot Bay to Casco Bay. These were fished daily, when weather permitted, up to the close of the season in late April. Windy but otherwise average weather prevailed during the entire fishing period, and a fair number of brood fish were taken, though they were less abundant in Casco Bay than usual, and the catch as a whole was somewhat smaller than the record one of last year. Right at the busiest part of the fishing season the steamer *Gannet* was again forced out of commission because of deficient boiler stay bolts and had to be laid up for two weeks. This, of course, resulted in the loss of large numbers of eggs, as it was impossible to reach the more distant nets with the small motor boats at hand. As an outcome of the season's fishing about 5,800 brood winter flounder were captured, and from them 1,585,685,000 eggs of excellent quality were secured, the aggregate losses during incubation being estimated at less than 6 per cent.

During the summer a very good display of local fishes, seals, crustaceans, and bottom material was maintained in the hatching room, constituting a source of attraction to the many visitors to the station.

Gloucester (Mass.) Station

[C. G. Corless, Superintendent]

Pollock propagation at this station extended from early November to January 17, but could not be prosecuted to advantage during the first two months owing to the severe storms that prevailed, and the egg collections of that species up to the close of December were the most discouraging in many years. Pollock were abundant on the fishing grounds and large numbers of them were spawning, but on account of the unfavorable weather many of the fishermen allowed their gill nets to remain in the water for from two to five days at a time and when finally they were hauled most of the fish contained in them were dead. Weather conditions improved after January 1, and up to the 10th of that month 400,000,000 eggs were taken, the work of a single day netting nearly 100,000,000. The total number of eggs of this species collected during the season was 698,579,000. The collection of cod eggs for stocking the Gloucester hatchery was undertaken on November 11, and by the close of November about 56,000,000 had been secured. The indications at that time were that cod would be plentiful throughout the winter, but early in December virtually all the fish left the inshore fishing grounds, and this, together with the scarcity of all other species of marine fish, caused the majority of the gill-net fishermen to suspend operations temporarily. With the improvement of weather conditions shortly after the 1st of March fishing was resumed, and the daily egg collections from that time on to the end of the season on April 30 were large, the total number of eggs taken amounting to 844,882,000.

During the latter part of April the low density of the water caused by heavy spring freshets made it necessary to plant 277,496,000 cod eggs on the spawning grounds as soon as they were fertilized. Haddock were late in appearing on the inshore fishing ground and were much later than usual in spawning. As a rule haddock are taken in considerable numbers during March, but no spawning haddock were seen in the spring of 1926 until April 11. To April 30, the close of the spawning period, 119,304,000 eggs of this species were collected. Early in March, as soon as weather conditions made it possible, fyke nets were set along the eastern shore of Gloucester Harbor with the view of obtaining brood winter flounder, but on account of the cold backward spring the catch was smaller than usual. The 295 gravid fish taken yielded 151,821,000 eggs.

Offshore operations from this station were taken up on February 1 and continuously prosecuted to April 2. Three experienced spawn takers were detailed to the work, one being placed on an otter-trawl steamer and the other two on hand trawlers. Although the spawn takers made more trips than in past years, the catch of fish was unusually large, and every effort was put forth to secure a record collection of eggs, the results of the work did not meet expectations. This was because only a small percentage of the fish taken were ripe. As an outcome of the work in this field 102,361,000 cod eggs and 50,787,000 haddock eggs were fertilized and planted on Georges Bank.

Woods Hole (Mass.) Station

[G. R. Hoffses, Superintendent]

Generally favorable weather prevailed during the spawning season of the fishes propagated in this region, and the outcome of the year's work was satisfactory in the main. Early in October arrangements were perfected for acquiring a brood stock of adult cod from the commercial fishing traps operating at Newport and Narragansett Bay, R. I. The first lot was obtained on November 5, and later acquisitions swelled the receipts to 1,794 fish, all being of desirable quality and so far as could be determined, equally apportioned as to sex and sexual maturity. Unfortunately this station is not equipped with proper means for transporting live fish from the fishing grounds to the station, and a boat equipped with a small well for carrying lobsters had to be chartered at an expense of $100 per trip. It was estimated that this boat would carry 425 cod safely from the Newport field to the hatchery, a distance of about 4 hours' duration; but a trial trip with that number having resulted in a loss of 140, the numbers carried on later trips were successively reduced. This proved of little avail, however, as on every trip the loss of fish amounted to 25 per cent of the load carried, and it could only be concluded that the type of boat used was not suited to the work.

In an effort to transfer the 1,794 brood cod purchased there was a mortality of 794, leaving only 1,000 available for the propagation work. It being apparent quite early in the season that, with the unsatisfactory transportation facilities available, the Newport traps could not supply fish in adequate numbers for the work, the local hand-line fishermen were requested to deliver their catches to the station. By this means the brood stock was increased to 1,750 fish, which yielded in round numbers 272,000,000 eggs. After the completion of spawning operations, the fish were tagged and liberated in connection with the investigation being made by the division of scientific inquiry concerning food fishes.

The work of obtaining brood winter flounder in the vicinity of Waquoit, Mass., was undertaken on January 12. Nets were set on the following day and, weather permitting, daily trips were made to the fishing grounds from that time to March 29. From the stock thus acquired, amounting to 2,516 female fish and a suitable number of males, 894,000,000 eggs were secured and incubated, the total losses amounting to 18 per cent.

During the month of June a small collection of mackerel eggs was made. At an earlier period both mackerel and scup were abundant in waters adjacent to the station, but they disappeared to a great extent in advance of the spawing time and only a very few of either species were to be found.

Of 25,000 steelhead-salmon eggs received from the Medford (Oreg.) field, about 70 per cent were hatched. The resulting fry were planted in Childs River.

ANADROMOUS FISHES OF THE ATLANTIC COAST

The fish-cultural work at the three stations of this class, located in Maryland, North Carolina, and Maine, was concerned with the propagation of shad, river herring, Atlantic salmon, and humpback salmon. The collection of eggs of these species were small, as compared with those of 1925, the cause of the falling off being the unfavorable weather experienced during the herring spawning season and the scarcity of adult shad both in the Potomac River and in Albemarle Sound.

Shad

Bryans Point (Md.) substation.—The outcome of the season's work in shad propagation on the Potomac River was very discouraging. While scarcity of adult shad was mainly responsible for the poor results, there were other contributing factors, among them being the unfavorable weather and water conditions encountered. The first fish of the season with mature eggs was taken on April 23, and from that time on the work was earnestly prosecuted up to the close of the run on May 14. Eggs to the number of 9,625,000, all of excellent quality, were secured and incubated, and the resulting fry were returned to the more important spawning grounds in the river.

A remarkable feature of the shad work on this river is that almost no shad are now being taken on the formerly prolific spawning grounds lying between the hatchery and the city of Washington, a distance of about 14 miles. From this territory, which until quite recently yielded from 10,000,000 to 25,000,000 eggs per season, the total number of eggs obtained during the past two years has amounted to only 650,000. From all the evidence obtainable the conclusion has been reached that this desertion of a formerly favored spawning area may justly be charged to pollution brought about by the extensive discharge of sewage into the upper river at various points.

Shad and River Herring. Edenton (N. C.) Station

[William S. Vincent, Superintendent]

On account of the prevalence of heavy adverse winds and unseasonable air and water temperatures, the spring of 1926 was one of the most unsatisfactory ever experienced in this region, not only from a fish-cultural standpoint but also as concerned the prosecution of commercial fishing. Shortly before the commencement of the anticipated spawning period of the river herring the commercial fish houses of the district were visited at regular intervals in quest

of ripe fish, but none was found until April 22, the season opening about two weeks later than usual. Throughout the month of April an interval of two or three fair days was invariably followed by high winds and cold weather. Such conditions prevailed until the first week of May, when, as a result of several successive warm days, a run of herring ascended nearer to the headwaters of adjacent streams than ever before so far as the records go. In the course of the egg-collecting period, which extended to May 6, 123,000,000 eggs (approximately one-third of last year's total) were secured. As was the case in a former season, the eggs were extremely adhesive, and despite the application of every known preventive in taking them and in their subsequent care the losses during incubation were excessive, amounting to about 60 per cent of the eggs collected.

The conditions encountered at Capehart Beach were the same as last year. The daily catch of shad was invariably small, and quite frequently it consisted of fish of only one sex. On the few occasions when both sexes were represented the females were green. Daily trips were made to the fishing grounds until it became apparent that no eggs would be obtainable, when they were discontinued.

Atlantic and Humpback Salmons. Craig Brook (Me.) Station

[George N. Montgomery, Superintendent]

On account of the unreasonable attitude assumed by the commercial fishermen of the Penobscot River with reference to the conduct of Atlantic-salmon propagation at this station, no local egg collections are made, and for the past few years the work with that species has been dependent upon the transfer of eggs from hatcheries operated by the Canadian Government, such eggs being in exchange for the spawn of other fishes. In the pursuance of work along this line 553,000 eyed eggs were received early in March from South Esk, New Brunswick, and a few days later a second shipment of 546,000 arrived from Gaspe, Quebec. One hundred thousand of the latter consignment were reshipped to the State hatchery at Caribou, Me., with the view of liberating the resulting fry in the waters of that region. From the remaining eggs 900,000 fry were developed in the Craig Brook hatchery and were utilized for replenishing the supply in the Penobscot River and other streams in Maine.

The run of humpback salmon to fresh-water streams of the State being due in the fall of 1925, preparations were made in advance of the spawning season for the collection of eggs in the Dennys River. The first fish in spawning condition was obtained on September 17, and in the course of the succeeding 10 days 1,134,000 eggs were secured. The loss on this lot during the hatching period amounted to about 9½ per cent.

FISHES OF MINOR INTERIOR WATERS

The more important fishes propagated at the stations included under this heading are the brook, rainbow, Loch Leven, and black-spotted trouts, the landlocked salmon, the black basses, the crappies, rock bass, sunfishes, and catfish. Due to the great extension in travel brought about by the rapidly increasing use of the automobile and the consequent opening of heretofore almost inaccessible regions, numerous streams that formerly contained an abundance of fish life have become almost depleted. This is particularly true of the brook trout and black basses, species for which there seems to be an inexhaustable demand. The output of brook trout from the bureau's hatcheries is limited by the necessity of depending largely upon commercial establishments as a source of supply for eggs, while in the case of the black bass and other pond fishes the work of producing them is hazardously affected at some points each year by sudden changes in temperature and other unfavorable weather and water conditions. Another handicap is the inability to secure brood fish in adequate numbers, while lack of sufficient rearing space hampers the work at almost all points. In an effort to alleviate this difficulty

the bureau has taken steps to cooperate with various fishing clubs and other organizations in rearing both bass and trout to the larger fingerling sizes before supplying them to applicants or liberating them in public waters.

ROCKY MOUNTAIN TROUT STATIONS

Fish-cultural operations at this group of eight stations and substations are confined to the various species of trout found in the mountain streams and lakes of the Rocky Mountain region. The species to which special attention was given during the year were the brook, rainbow, black-spotted, and Loch Leven trouts, while at one of the stations grayling were handled in comparatively small numbers.

Bozeman (Mont.) Station and Substations

[W. T. Thompson, Superintendent]

The cooperative relations heretofore maintained with the Montana Fish and Game Department were continued throughout the year. The exchange of fish eggs on a large scale between the station and the State is proving mutually beneficial and economical. Were each organization compelled to maintain fields for the collection of the species exchanged, the expense of conducting the work would be materially increased.

Bozeman (Mont.) station.—During the excessively warm weather experienced in July a severe outbreak of Octomitiasis occurred among the brook-trout fingerlings carried over from the stock of the previous fiscal year, and about 165,000 perished before the disease could be checked. During December and January 1,569,500 eyed brook-trout eggs were acquired, of which 270,000 were donated to the station by the Southside Sportmen's Club of Oakdale, N. Y. Part of the fry hatched from this stock of eggs were distributed during the spring, and about 620,000 were on hand in the fingerling stage at the end of June. Large numbers of rainbow, black-spotted, and Loch Leven trout fingerlings were being carried at the beginning of the year, together with a small number of landlocked salmon. In advance of the distribution period these fish were attacked by the same disease that occurred among the brook trout and heavy losses resulted. In addition to a small number of eggs obtained from the station brood stock of rainbow trout, 624,000 eyed eggs of that species were transferred to the station from the Meadow Creek field. At the close of the year the young fish produced from these eggs were being reared for later distribution.

During January and February 1,796,000 eyed Loch Leven trout eggs were transferred to the Bozeman hatchery from the Meadow Creek auxiliary. All of these, with the exception of 41,000 retained at the station, were immediately repacked and shipped, some to applicants and some in exchange for eggs of other species. The entire stock of 1,554,000 black-spotted trout eggs handled was received from the Montana Fish and Game Department, the eggs having been collected during May and June near Georgetown, Mont. On reaching the eyed stage 500,000 were shipped to the New Mexico Fish and Game Department and 325,000 were used for stocking mountain lakes in Montana. The remainder were incubated in the hatchery.

Meadow Creek (Mont.) substation.—Soon after the collection of the first Loch Leven trout eggs of the season on October 13 unfavorable weather set in, which delayed further operations until about the middle of November, at which time a large run of fish appeared in the stream. Between November 15 and December 8, 12,220,000 eggs of this species were taken, establishing a new record in the work of the substation. For some unknown reason the losses of eggs were large during the incubation period, the percentage of hatch being only 72½, as compared with 90½ per cent hatched the preceding year. The rainbow trout began spawning on April 12, somewhat later than usual and between that date and May 19, 2,698,000 eggs were taken. Though considerably smaller than the collection in 1925, the quality of the eggs was far superior, the number brought to the eyed stage amounting to 92 per cent of

the whole. Eyed eggs to the number of 1,143,500 were transferred to the Bozeman and Glacier Park hatcheries; the remainder were incubated locally and the product used for restocking Madison Valley waters.

Glacier Park (Mont.) substation.—The large number of black-spotted trout fingerlings on hand at the opening of the fiscal year were planted during July and August in the waters of Glacier Park by local park officials, together with the considerable numbers of rainbow trout and grayling fry turned over to them as part of the product of the hatchery at this point. During May and June 1,486,000 green black-spotted trout eggs were received from the Montana Fish and Game Department, 350,000 of which were planted in the headwaters of some of the more inaccessible streams in the park; the remainder were on hand at the end of the fiscal year. The substation also received 519,520 rainbow-trout eggs from the Meadow Creek field and 1,075,000 green grayling eggs from one of the Montana State hatcheries. The product of the latter lot was delivered to Glacier Park officials for distribution in waters adapted to that species, while the fry hatched from the rainbow-trout eggs were carried over into the new year.

Leadville (Colo.) Station

[C. H. Van Atta, Superintendent]

All brook-trout eggs handled at this station are obtained from privately owned lakes or reservoirs, collections being made on a percentage basis. Heretofore five egg-collecting fields have been occupied, but last year, owing to a decision of the parties in control to allow outside interests to make collections in Carroll Lakes, Woodland Park, only four sites were covered. From these four 5,955,000 eggs were secured, about 50,000 less than the preceding year's total. The cost of collecting the green eggs varied from 1½ cents per thousand at Wurtz Lake to 20 cents per thousand at Turquoise Lake, the average for all fields being 6 cents. The wide variation between the two fields named is due to the fact that at Wurtz Lake all fish are seined by the owner and held in ponds awaiting the collection of the eggs by the bureau's employees, while at Turquoise Lake the fish must be seined from the lake by the bureau's men, which requires the full time of two station employees. In this connection great difficulty frequently is encountered, as the lake is liable to freeze over early in the season, and then the fish must be secured by seining for them under the ice.

At Engelbrecht Lakes the eggs are collected and cared for during the incubation period on a 30–70 basis. The owner furnishes board and lodging for the spawn taker and receives as his share 30 per cent of the resulting fry, the delivery being made at his nearest railroad station. All eggs from this field formerly were forwarded to the hatchery by train, but in the fall of 1925 the transfers were made by auto truck over a recently constructed highway until such time that it became blocked with snow. The attendant losses under the new method were greatly reduced, being less than half as large as those sustained during the previous year.

With the view of developing an egg-collecting field for rainbow-trout spawn, plants of fish of that species have been made in Baker Lake for the past four years, about 98 miles distant from the hatchery. This field station was worked for the second time in May, 1926, the yield of eggs amounting to 181,300. Bolts Lake, another rainbow-trout project, is being stocked annually with fingerling fish under a 10-year agreement, in accordance with the terms of which the bureau will receive 70 per cent of the eggs derived from its waters. From 356,000 black-spotted trout eggs received from the Yellowstone Park during the summer of 1925, 326,500 No. 1 fingerling fish were produced and distributed in waters in Colorado and New Mexico. In the course of the year the station handled 30,000 lake-trout eggs, received from the Duluth (Minn.) hatchery, 25,000 steelhead salmon eggs forwarded from the Birdsview (Wash.) field, and 50,000 rainbow-trout eggs, shipped from the Saratoga (Wyo.) station. All of these were received in excellent condition, and the fry resulting from them were still on hand at the close of the year.

Yellowstone National Park (Wyo.) Substation

[C. F. Culler, in charge]

Coming as it does in the late spring and early summer months, the fish-cultural work in this field covers portions of two fiscal years. At the beginning of July, 1925, about 6,000,000 black-spotted trout eggs were being carried in the hatchery, and the collections from that time to the close of the spawning period on July 21 brought the season's total to 11,748,000, as opposed to the collection of nearly 32,000,000 the preceding year. The principal cause for this falling off in numbers is attributed to the unusually high water stages in the streams and lakes and the abnormally low water temperatures, both of these conditions resulting from the melting of vast quantities of snow in the adjacent mountains. The low temperature in the open waters induced spawning in the much higher temperatures found on the beaches in the lakes. As an offset to the shortage in numbers, the quality of all spawn taken was of a high grade, the percentage of hatch being somewhat higher than that attained in the work the previous year.

As an experiment, 200 of the spawned-out fish were tagged before liberating them in the streams where they were captured, the object being to ascertain if they would return to the same streams to spawn in the succeeding year. Close observations made up to the close of the fiscal year 1926 disclosed the return of only three of the tagged individuals.

Saratoga (Wyo.) Station

[S. M. Ainsworth, Superintendent]

Fish-cultural operations in this field were limited to the propagation of the brook, rainbow, and Loch Leven trouts, the combined output of which exceeded that of the previous fiscal year by approximately 1,600,000. Considerable difficulty was experienced in planting the stock of brook-trout fingerlings on hand at the beginning of July, bad weather and nearly impassable roads, coupled with inability to get into prompt communication with the Forest Service employees who were to receive the fish, greatly retarding the distribution. From the station brood stock of brook trout 131,000 eggs of excellent quality were secured, the percentage of hatch exceeding 91. In the conduct of brook-trout work in the Big Creek Lakes field a heavy storm occurring early in the spawning season raised the water level of the upper lake so high that practically all of the brood fish in the traps were liberated, and before the traps could be replaced the majority of the trout had passed into the second lake, where they were inaccessible. Immediate steps taken to seine some of the fish remaining in the vicinity of the trap site resulted in the capture of a sufficient number to yield 403,000 eggs.

Arrangements were made to enter the Lost Creek field for the collection of eggs from wild rainbow trout during the last half of March, the weather being warm at that time and indicating an early spawning season. Soon after arriving on the ground, however, cold weather again set in and continued until late in April. Eggs were obtained in this field from Lost Creek, Sage Creek, and Canyon Creek between April 30 and May 26, the total number collected during the season being 1,952,000. Of these, 1,153,000 were shipped, and from the remainder 407,000 fry, representing 28 per cent of the stock brought to the eyed stage, were liberated in parent streams.

During the fall spawning season 318,000 Loch Leven trout eggs were obtained from the station brood stock of 900 female fish, almost all of which were under 3 years of age. Of the resulting fry 111,000 were planted in public waters or distributed to applicants, leaving about 159,000 on hand at the close of June.

Spearfish (S. Dak.) Station

[D. C. Booth, Superintendent]

This station accomplished a considerable amount of work in the line of pond construction during the year. Brood-trout ponds that were too shallow for carrying large fish successfully were deepened; two of them were thrown together to form one large pond and were connected with the spring-water supply from the hatchery, thus reducing the lower average of the water temperature. A series of 11 concrete nursery ponds was constructed immediately

adjoining the hatchery building and fitted up to receive spring water that has passed through the hatchery. Between October 24 and December 22 brook-trout eggs to the number of 637,200 were collected from brood fish held in the station ponds. These were of good quality and over 90 per cent of them were hatched. Five hundred thousand eyed brook-trout eggs were received from the State of South Dakota in exchange for eggs of the Loch Leven trout, and 1,118,700 additional eyed eggs of that species were handled in pursuance of an agreement entered into with the authorities of that State, whereby the State was to defray all expenses connected with the purchase of the eggs from a commercial firm while the bureau was to incubate them and care for the resulting fry until May 1, at which time they were to be divided, the State receiving two-fifths and the bureau the remainder. As a result of this cooperative work the bureau received more than 452,000 fingerling trout for distribution to applicants. The year's work at this point included the collection of 203,200 Loch Leven trout eggs and 43,200 rainbow-trout eggs from the station brood stock, all of which were incubated with only small losses.

Springville (Utah) Station

[Claudius Wallich, Superintendent]

The year's fish-cultural work in this field was concerned with the propagation of the brook, rainbow, and black-spotted trout. Though the stock of eggs handled in the course of the year was large, none of the resulting fry were distributed until the No. 1½ fingerling stage had been attained, and more than 37,000 were from 5 to 6 inches long when disposed of. All of the fish were in first-class condition when shipped, and as only a comparatively small number of the larger sizes could be carried to a can, their distribution involved numerous messenger trips. The brook-trout work at Fish Lake, Utah, was taken up early in October, at which time one of the station employees was detailed there at the request of the State fish commission to assist in guarding the brook trout from the depredations of poachers. The first eggs taken in this field arrived at the main station on October 28, and further shipments, extending to December 9, brought the total receipts for the season up to 2,836,000, of which number 85 per cent were brought to the eyed stage. Shipments of eyed eggs totaling 1,785,000 were forwarded to applicants and other stations of the bureau. The remainder were incubated at the station.

The rainbow trout on hand at the opening of the fiscal year were carried to the No. 3 fingerling stage before being distributed. Eggs were taken from the brood stock of this species held in the station ponds between November 27 and March 17, the yield (from 1,137 female fish) amounting to 1,669,700 eggs. Though extreme care was exercised in the impregnation of the eggs, for some unknown reason, the percentage of fertilization was poor, and only a little over half of the collection hatched. From eggs secured from wild stock at Fish Lake, during the spring, in cooperation with the State of Utah, the station acquired 950,000 additional spawn. Some of the eggs were of inferior quality, but later receipts were of a much higher grade and yielded a large percentage of fry. No black-spotted trout egg collections were undertaken by the station force and the year's work with this species was confined to the incubation of 265,000 green eggs, received in connection with collections made by the State fish commission in Strawberry Reservoir. The fertility of these eggs was also poor, only about 47 per cent of them producing fry.

NEW ENGLAND TROUT AND SALMON STATIONS

The four stations comprising this group are located in Maine, New Hampshire, Vermont, and Massachusetts. Their work and that of their substations is concerned principally with the brook and rainbow trout and the landlocked salmon, though small numbers of lake trout, Loch Leven trout, smallmouth black bass, steelhead salmon, and humpback salmon also appear in their tables of output.

Berkshire (Mass.) Station

[W. H. Thomas, Superintendent]

The station brood stock of brook trout, consisting of 104 adults and 72 yearling fish, yielded 216,000 eggs. These eggs began hatching early in January, and incubation was completed on March 2, about 82 days from the time they were taken, the average water temperature for the period being 45°. Hatching proceeded satisfactorily, and the young fish appeared to be healthy up to January 19, when the fry from the oldest lot of eggs began settling to the bottom and lower ends of the trough. On January 23 the second oldest lot of fry began to show signs of disease, and each of the remaining lots was similarly affected on reaching the same age. By February 2 the disease among the two oldest lots of fish had reached an advanced stage and finally resulted in the loss of all fry in the hatchery except about 11,000. In the last week of December 150,950 brook trout eggs of excellent quality were received from the South Side Sportsmen's Club of Long Island. They were divided into two lots, one lot being carried in spring water at an average temperature of 44°, while the other was placed in pond water at 40°. At the expiration of 34 days the eggs in the spring water had hatched, but the period of incubation of those held in pond water was extended to 51 days. Both lots were of uniformly good quality and there was no unusual loss. At the close of the year, however, the fish held in spring water averaged 1¾ inches in length while those retained in pond water were one-half inch shorter. A consignment of 57,500 rainbow-trout eggs was received from the Bozeman (Mont.) field on June 8, and the resulting fry were on hand at the end of the year. No brood bass were obtained for breeding purposes, but 1,660 Nos. 3 and 4 fingerling smallmouth black bass, carried over from the work of the previous year, were distributed in November, 1925.

Craig Brook (Me.) Station and Substations

[George N. Montgomery, Superintendent]

Under the heading "Anadromous fishes of the Atlantic Coast" (p. 359) will be found a summary of the operations at this station in the propagation of Atlantic salmon and humpback salmon. During the fall of 1925, 25,500 fingerling land-locked salmon ranging in length from 2 to 3 inches, which had been carried over from the stock of the previous fiscal year, were distributed to applicants and planted in suitable public waters. From adult landlocked salmon taken in trap nets set in Toddy Pond 5,165 eggs were collected and early in November 124,050 green eggs were received from the Green Lake substation. On attaining the eyed stage 110,000 of these eggs were supplied to applicants and to other stations of the bureau; the remainder (about 10,000) were hatched at the station, together with 200,000 eyed eggs of this species transferred from the Grand Lake Stream substation and 218,250 transferred from the State hatchery at Caribou, Me. All of these were incubated with merely nominal losses, and the resulting fish were released in suitable waters as advanced fry and fingerlings or reserved at the station to be reared to a larger size. Brook-trout eggs (13,630) collected from brood fish in the station ponds were of poor quality, only about 46 per cent of fish hatched from them surviving to the No. 1 fingerling stage. Other eggs of this species included 580,000 eyed eggs received from dealers in Pennsylvania and Massachusetts in exchange for those of other species and 751,000 purchased from commercial dealers in Maine and New York, 175,000 of the latter being used for stocking the Grand Lake Stream hatchery. An excellent percentage of hatch was secured from all these eggs excepting those received from the Maine dealer, on which there was a loss of about 36 per cent. All of the young brook trout resulting from this stock were distributed during the spring or planted in suitable public waters, with the exception of 143,000 fingerlings. These were on hand at the close of the fiscal year.

Grand Lake Stream (Me.) substation.—Late in the fiscal year 1925, 150,000 landlocked-salmon fry were placed in the canal ponds and fed at regular intervals from three to five times a day on a diet of sheep plucks. It was noted that after eating all particles of the heart and liver in sight the fish would greedily consume the lungs, which floated on the surface of the water. The 132,405 strong, healthy fish resulting from this lot were liberated as 3-inch

fingerlings in Grand Lake and its tributaries during September. It having been noted that virtually all losses among the fish held in these canal ponds occur during July, when the water is comparatively warm, steps were taken to counteract this condition by providing a stronger flow of water through the ponds, thus obviating sudden changes in temperature to a great extent. Preparations for the collection of landlocked-salmon eggs were undertaken on October 18, when arrangements were made to set trap nets above the screen at the dam in Grand Lake. From the three trap nets operated 339 female and 264 male landlocked salmon were taken, this stock yielding 799,400 eggs of good quality. The adverse weather encountered during the fall tended materially to reduce the collections. An effort to obtain lake-trout eggs in Grand Lake during the month of October met with complete failure. High winds and rising water interferred with the nets and no fish were captured. From the stock of 175,000 brook-trout eggs transferred from the Craig Brook station 166,000 fry were produced, all of which were distributed to applicants with the exception of 5,000. These were on hand at the close of the year.

Green Lake (Me.) substation.—On October 15 traps were installed in Great Brook and Green Lake, and during the run of landlocked salmon in these streams 30 male and 65 female fish were captured, from which 120,050 eggs of fine quality were taken. It being impossible to develop the eggs in the water on hand at Green Lake, they were forwarded to the main station to be incubated.

St. Johnsbury (Vt.) Station and Substation

[A. H. Dinsmore, Superintendent]

This field includes the work at the main station at St. Johnsbury and at the York Pond (N. H.) substation located in the White Mountain forest reserve. In the course of the fiscal year the substation at Holden, Vt., was transferred to the division of scientific inquiry of the Bureau of Fisheries, to be used as a base for conducting experiments in the feeding of fish and the treatment of diseases of the Salmonidæ. Operations at St. Johnsbury station were confined to the incubation of trout eggs and the distribution of the fry hatched from them. The work at York Pond substation was principally of a constructive type, though it included the handling of a comparatively small number of brook trout.

St. Johnsbury (Vt.) station.—As in the previous year, arrangements were made to hatch brook-trout eggs collected at Darling Pond, Vt., the bureau receiving as its share of the product one-third of the fry hatched. The usual number of brook-trout eggs were purchased from commercial fish culturists, and two local fishing clubs delivered a considerable number of these eggs to be incubated at the hatchery with the understanding that the resulting fry would be returned to them for deposit in certain public waters in the State. The losses on stock obtained from commercial firms were somewhat above normal, especially during the fry stage. About 1,343,000 eggs of this species were handled during the season, and the output exceeded that of the preceding year by more than 100 per cent.

The usual lake-trout egg collections were made at Lake Dunmore in cooperation with the State of Vermont during a period extending from October 25 to November 3. The bureau's share of these eggs was incubated at the St. Johnsbury and Holden stations, and the resulting fry were delivered to applicants and planted in local waters. The station received a consignment of steelhead-salmon eggs shipped from the Pacific coast, one of Loch Leven trout eggs from the Bozeman (Mont.) field, and another of landlocked-salmon eggs from the Craig Brook (Me.) station. All of these were hatched successfully with the exception of the last-mentioned lot, on which there was an unusually heavy loss.

York Pond (N. H.) substation.—Development work on this project, which is intended eventually to supply a large part of the brook-trout eggs the bureau is now compelled to purchase, has been in progress whenever weather conditions would permit. Work on the west branch of the diversion ditch was greatly impeded by unfavorable weather. However, the clearing of the ground and the excavation of about 1,400 feet of the ditch was accomplished during the fall, and the work was resumed early in May. A road machine operated by a tractor was secured, and with the exception of some high places the

entire 14,000 feet of ditching was completed. Brook-trout spawning operations began on September 24 and continued to November 13, during which time 313,000 eggs were taken from the 851 female fish collected in the station ponds. These eggs, with the exception of 15,000 that were shipped to the Holden station, together with 60,000 forwarded from St. Johnsbury station, were incubated at the York Pond substation, and the resulting fry were released in local waters.

Nashua (N. H.) Station

[J. D. De Rocher, Superintendent]

The brook-trout eggs obtained from the station brood stock were of such poor quality that only about 98,000 of the 155,000 collected were hatched, and the losses in the fry and fingerling stages were very large. This stock of eggs was supplemented by 892,000 purchased from commercial fish culturists in Pennsylvania, and 98,980 were received from the State of Massachusetts in exchange for eggs of the Loch Leven trout. A higher degree of success attended the incubation of these eggs, though the losses on the resulting fry and fingerling fish were heavy. From the total number of eggs of this species purchased and received through exchange 743,000 fingerling fish were produced, part of which were distributed before the close of the year. In addition to the brook-trout eggs referred to above, 164,720 were donated to the station by a commercial fish-culturist in New York State. This lot appeared to be of fair quality when received, but the fry hatched from them were weak and died rapidly, scarcely any of them reaching the fingerling stage.

Very heavy losses attended the work with the station brood stock of rainbow trout. From 156,000 eggs of this species taken during the fall and laid down for incubation in the hatchery only 32,000 fingerling fish were produced for distribution during the spring. Approximately 17,000 fingerling Loch Leven trout were produced from 25,000 eggs forwarded from the Bozeman (Mont.) field, and 10,150 landlocked-salmon fingerlings resulted from 15,150 eyed eggs transferred from the Craig Brook (Me.) station. Both these lots of fish were on hand at the close of the fiscal year.

For a number of years past the hatchery and water supply have been in very poor condition. An appropriation for making needed improvements was secured recently and the work of reconstruction is now in progress.

COMBINATION TROUT AND POND STATIONS

The five stations comprising this group are located in Iowa, Missouri, Tennessee, Virginia, and West Virginia. Their output during the fiscal year 1926 aggregated approximately 6,000,000 fish, the species represented being brook trout, rainbow trout, Loch Leven trout, largemouth black bass, smallmouth black bass, rock bass, bream, crappie, and catfish. In addition to the distribution of fish, a considerable number of rainbow-trout eggs were furnished in the eyed stage to applicants and to other stations of the bureau.

Erwin (Tenn.) Station

[A. G. Keesecker, Superintendent]

In the course of the year a number of improvements were made to the pond system at this station, among the more important of them being the construction of a cement wall about 180 feet long on both sides of pond No. 38 to protect the banks from erosion and the depredations of muskrats. Other changes included the installation of a new outlet in pond No. 33 and an emergency water inlet in this pond and also in pond G.

The fish-cultural work was concerned with the propagation of rainbow and brook trout, largemouth black bass, rock bass, and sunfish; and small numbers of catfish, crappie, and goldfish were produced incidentally. The collection of eggs from the station brood stock of rainbow trout was taken up on November 2 and was continued at semiweekly and weekly intervals to January 12, the yield aggregating 644,500. As many of the brood fish were young the losses of green eggs were unusually heavy, only 64 per cent reaching the eyed stage.

Shipments totaling 131,640 eyed eggs were forwarded to the State hatcheries at Waynesville and Marion, N. C., and the young fish hatched from the remainder were distributed as fingerlings to applicants. During the spring of 1926, 24,580 eyed rainbow-trout eggs were received from the Madison Valley (Mont.) field. The product of these will be utilized to augment the station brood stock. In its work with the brook trout this station always has depended upon purchases of eggs from commercial fish-culturists, but during the past season 396,000 brook-trout eggs were received from a dealer in Pennsylvania in exchange for eggs of other species. The fry resulting from these eggs were reared to fingerlings Nos. 1½ and 2 before being distributed.

The total output of pond fish of all species slightly exceeded that of the previous fiscal year, and about 50,000 black bass, rock bass, and sunfish were on hand at the close of the year.

Manchester (Iowa) Station

[G. H. Gill, Superintendent]

The serious damage to the station occasioned by the flood in June, 1925, which included the loss of virtually all brood fish on hand, was largely repaired in the course of the fiscal year 1926. The large quantities of sand and refuse deposited were removed from the ponds and grounds, the roadways were rebuilt, broken pipe lines replaced, and a new 55-foot truss bridge with cement flooring was constructed across Spring Branch. A retaining wall 190 feet long, 10 feet high, and 2 to 3 feet thick was built as a protection against future floods.

A considerable number of adult rainbow trout that escaped during the flood into Maquoketa River and Spring Branch were later recovered by seining. This stock of 650 fish yielded 419,000 eggs, of which 111,000 in the eyed stage were exchanged for eggs of the brook trout. The remainder were incubated. During the spring a consignment of 25,000 eyed eggs from wild rainbow trout, received from the Bozeman (Mont.) field, were successfully incubated. The product of these eggs will be reared for a future brood stock. In addition to the older brood fish on hand, the station has about 800 yearling rainbow trout and a large number of 8 to 10 inch fingerlings, and it is anticipated that it will soon be in a position at least to equal its former large production of eggs.

During November and December 700,000 brook-trout eggs and 100,000 Loch Leven trout eggs, all of them eyed, were received. The former lot, furnished by a commercial dealer in Colorado in exchange for eggs of other species, was incubated with light loss, and about half of the product was distributed as fingerling fish. The remainder are being held for later distribution. An excellent percentage of hatch was attained from the Loch Leven trout eggs, and all but 36,000 of the resulting fingerlings were distributed prior to June 30.

Owing to the loss of brood stock and the damage to the ponds, only a negligible number of pond fishes were produced. These were being held at the close of the season for distribution when the ponds are drained in the fall. Small numbers of brood largemouth black bass, smallmouth bass, and sunfish have been secured, and the production of these fishes on a larger scale will be resumed during the coming season.

Neosho (Mo.) Station and Substations

[J. P. Snyder, in charge]

As in the past, fish-cultural activities at this station were directed mainly to the propagation of rainbow trout and largemouth black bass, though small numbers of fish of other species were produced incidentally. The largest season's collection of rainbow-trout eggs ever made here was obtained from the station brood stock between November 1 and February 28, the total amounting to 1,640,000, of which 77 per cent were developed to the eyed stage. Eyed eggs to the number of 1,081,000 were supplied to applicants and to other hatcheries of the bureau. When the fry hatched from the remaining eggs were a month old they were suddenly attacked by some disease, the most noticeable symptom being a swift darting and whirling motion. They refused to eat, became thin, and the death rate increased rapidly. Light salt baths were given without apparent effect, but a marked and immediate improvement was shown in the condition of a lot that was immersed experimentally in a

strong brine solution. The darting circling movement ceased at once, the fish fed ravenously and began to make a rapid growth. All the affected fish in the hatchery were then given the same treatment, and two weeks later on the reappearance of some of the symptoms, these were quickly dispersed by another application of the solution. From that time on the fish gained in health and there was no recurrence of the trouble. Many of them were distributed in the spring, and all that remained on hand at the close of the year were normal in every respect, being at that time fingerlings from 2½ to 5 inches long.

From 50,000 eyed Loch Leven trout eggs received from the Bozeman (Mont.) field 49,700 fry were hatched. At the outset the young fish appeared to be in good condition, but they weakened later and many died, the remedial measures resorted to affording but little relief. The survivors, amounting to about 40 per cent of the original stock, were distributed to applicants in the No. 2 fingerling stage.

The outcome of the work in the propagation of the pond fishes was materially less successful than in 1925, the distribution of all species amounting to only 83,755, as compared with 152,072 in the preceding year.

Bourbon (Mo.) substation.—This station is operated under a cooperative agreement with the Von Hoffman Press Estate, of St. Louis, Mo., and in accordance with its terms the bureau receives a certain percentage of all eyed rainbow-trout eggs produced, that being the only species of fish handled. As the result of a large loss of brood fish early in the season, the rainbow egg collections made between November 15 and February 15 proved somewhat disappointing. The bureau received 583,185 eyed eggs as its share and shipped them all to applicants in Missouri, Colorado, and Arkansas.

Langdon (Kans.) substation.—In addition to the fish obtained from the Cattle ponds, which are leased by the bureau, considerable numbers of fish were purchased from owners of ponds in the immediate vicinity. The results of the year's work in this field were about the same as in the preceding year.

White Sulphur Springs (W. Va.) Station

[Edw. M. Haynes, Superintendent]

Air and water conditions during the year were in the main suitable for fish-cultural operations, and under these favorable auspices the station was able to produce a record output of brook trout and rainbow trout. One of the most favorable features of the work was the comparative freedom from fish diseases. Though all available space in the troughs and ponds was crowded to its utmost capacity throughout the season, the percentage of eggs hatched was excellent while the losses of fry and fingerling fish were small and all stock was strong and vigorous when distributed.

At this station the brood stock of rainbow trout consists principally of fish 2 and 3 years old, past experience having demonstrated that young fish are apt to be stronger and more virile than older ones and their eggs of a better quality. The policy has therefore been adopted of liberating the older stock in local streams immediately after the close of the spawning season and replacing them with young fish reared for the purpose. The rainbow trout began spawning on October 28, about two weeks earlier than last year, and the last eggs of the season were taken on January 11. The yield amounted to 1,480,000, of which 71 per cent were brought to the eyed stage. A total of 229,150 eyed eggs was shipped to applicants and other stations of the bureau. The remainder were hatched and the product reared to the fingerling stage, at which time most of them were distributed. Part of the 20,000 fish of this lot on hand at the close of the year are intended for brood stock.

As only a few adult brook trout are maintained at this point, the egg collections aggregated only 67,000. In pursuance of a cooperative agreement the State of West Virginia purchased 1,002,000 eyed brook-trout eggs from a commercial dealer for incubation in the station hatchery, and 1,301,100 eggs were acquired from other sources, principally through exchange for eggs of other species. Virtually all of the eggs were of fine quality and produced healthy fry, the percentage of hatch on the various lots ranging from 93.2 to 98.4 per cent. Among them were 5,000 eggs from albino trout, donated by the Minnesota fish commission. The fish from this lot will be reared for use as a brood stock.

A brood stock of Loch Leven trout produced 47,000 eggs, and a consignment of about 290,000 eggs of this species were received from the Bozeman (Mont.) field, of which 150,000 were the property of the State of West Virginia. The State's share of the product of these eggs was turned over to the proper authorities in the fingerling stage for distribution in West Virginia waters.

Owing to the high altitude of this station its work with pond fishes is curtailed quite frequently by sudden fluctuations in temperature. The work of the past year along that line proved no exception to the general rule, and the results of such efforts were small.

Wytheville (Va.) Station

[C. B. Grater, Superintendent]

The abnormally dry weather that prevailed in the fall of 1925 seriously impaired the quality of rainbow-trout spawn and curtailed the egg-collecting period, which was more than three weeks shorter than in any previous year in the station's history. Eggs to the number of 427,000 were collected between October 29 and January 20, this total being less than half the yield of the preceding year. The unfavorable water conditions were clearly reflected in the losses of eggs and fry, approximately 39 per cent of the stock perishing before reaching the fingerling stage. Hardening of the food sac occasioned considerable loss, this abnormal condition persisting until long after all fry had begun feeding; while popeye and Octomitiasis figured extensively in the heavy mortality that occurred among the finger-ling fish. The fry hatched from a consignment of 25,000 rainbow-trout eggs received from the Montana field were healthy and vigorous. This lot will be held and reared as a future brood stock for the station.

The same diseases that were encountered in the propagation of the rainbow trout virtually nullified the results of the work with the brown trout. Of the 76,000 fry of that species hatched from eggs taken in the fall of 1925 from the station brood stock only about 3 per cent survived to the No. 2 fingerling stage. Four hundred thousand brook-trout eggs received from a commercial dealer in Pennsylvania in exchange for eggs of the Loch Leven trout furnished by the Bozeman (Mont.) station were only of fair quality, and the distribution of the resulting fingerlings was much smaller than that of the preceding year.

Fairly successful results were attained in the work with the pond fishes, and the total output of fish of that class exceeded that in 1925 by more than 65,000. As in past years, considerable difficulty was experienced in obtaining a brood stock of largemouth bass, and with the view of obviating difficulties along that line during the coming season a number of yearling fish are being reserved to supplement the brood stock. The yield from the 230 adults of this species amounted to 265,000 fry and fingerlings. The distribution of this stock was made during May and June.

The results attained with 42 adult smallmouth black bass transferred from the Lake Erie field in the fall of 1925 are considered encouraging, especially in view of the uniform failures that attended all former efforts to propagate that species. In advance of the spawning season 30 of these fish, equally divided as to sex, were placed in a brood pond, and the remainder, which could not be distinguished as to sex, were left in their winter quarters. This mode of treatment proved successful, the yield of the two inclosures amounting to more than 34,000 fry and fingerling fish. The station also produced for distribution small numbers of rock bass and bream.

PONDFISH-CULTURAL STATIONS

This group includes seven main stations and four substations, whose work was concerned entirely with the so-called "pond" fishes. Their aggregate output compares favorably with the average of recent years, though it was considerably less than in 1925. Most of this decrease occurred in the production of largemouth black bass, the number of that species distributed being approximately 500,000 less than in the preceding year. The reduced yield is attributable partly to the prevalence of unfavorable weather during the spawning period and partly to inability to secure an adequate number of brood fish.

Cold Spring (Ga.) Station

[Charles A. Bullock, Superintendent]

A number of changes in the pond system at this point were made necessary by the recent construction of a new highway across a portion of the station grounds. The most important of these changes were the enlargement of several ponds and the construction of three new concrete overflows in other ponds.

It is customary at this station to drain all breeding ponds as soon as the young fish in them have been distributed (usually about August 1), and to allow them to remain dry until the 1st of February. The object of refilling the ponds at this time is to induce a larger growth of plankton than would be obtained otherwise. Because of hindrance by the road-building operations the work of refilling the ponds last season could not be attended to until March 1, at which time it is necessary to transfer the brood fish from their winter quarters to the ponds. The brood stock of largemouth black bass was augmented in advance of the spawning season by the purchase of 300 adults from the owner of a large lake near Milltown, Ga. The year's output of this species, to the propagation of which the work of the Cold Spring station is confined, has been exceeded only once in its history. This was in 1925, when approximately 125,000 more fish were distributed than in 1926.

Much difficulty has been experienced in procuring suitable fresh food in sufficient quantities to maintain the station brood fish. A shortage in the market supply of fresh-water mullet, the most satisfactory material heretofore obtainable, necessitated the substitution of the so-called "northern fresh-water mullet," on which some kind of preservative apparently had been used. It having been ascertained early in May that shrimp heads were a waste product in the shrimp industry, a trial shipment of that material was obtained. The bass ate it greedily, and in the future supplies of this material will be obtained at regular intervals if it is possible to do so.

Harris Ponds (Ga.) substation.—This auxiliary, consisting of a series of ponds situated about 4 miles from the main station, is devoted entirely to the production of bream and catfish. The ponds usually are drawn in early August and the fish in them transferred to the Cold Spring station ponds for distribution later in the season. A steady increase is noted in the annual output of these ponds, last year's excess over the output of the preceding year being about 30,000 fish.

Edenton (N. C.) Station

[W. S. Vincent, Superintendent]

Extensive improvements were made to the pond system during the year, the changes including the enlargement of one of the ponds to twice its former size. Though the station's production of pond fishes was smaller than last year's by approximately 45,000, this shortage was at least partly compensated by the larger size of the fish distributed. Owing to the adverse weather prevailing during February, the collection of brood yellow perch from commercial fishermen was delayed until March, and when finally acquired it was found that many of the 300 adults assembled had already spawned. Owing to this delay, only about 1,500,000 eggs were collected for the station. In addition to its output of black bass and yellow perch, the station produced and distributed small numbers of sunfish, crappie, warmouth bass, and catfish. A discussion of the shad and river herring work will be found on page 358 under the heading "Anadromous Fishes of the Atlantic Coast."

Louisville (Ky.) Station

[C. W. Burnham, Superintendent]

Though the spawning of the various pond fishes was greatly retarded by the cold, backward spring, natural conditions were generally favorable to nesting operations from May 1, when the first eggs were deposited, up to the close of the fiscal year. The output of fry from the brood largemouth black bass that had been held in the station ponds for several years was somewhat disappointing; but the results with smallmouth bass were quite satisfactory, the distributions of that species being slightly larger than those of any previous year in the history of the station. These results were attained with four breeding ponds, each of which was three-fourths acre in area, the available

brood stock of 515 fish being apportioned between them early in April. In preparing the smallmouth bass fry for shipment they were transferred direct from the ponds to the shipping containers, thus necessitating only a single handling. As the production of young bream was considerably greater than the demand for them, the surplus remaining after all listed applications had been filled was utilized in stocking suitable public waters within reach of the station. The year's distributions included small numbers of rock bass and channel catfish, the latter being obtained by collection from the Ohio River.

Lake-trout fry to the number of 14,750, the product of 15,000 eyed eggs forwarded early in March from the Duluth (Minn.) hatchery, were turned over to the Kentucky Game and Fish Commission for use in stocking a reservoir on the Dix River in Mercer County, Ky.

Mammoth Spring (Ark.) Station

[Dell Brown, Superintendent]

In its work with the pond fishes, this station had one of the most successful seasons in its history. In October, 1925, the pond devoted to rock-bass culture was drained, and more than fifteen thousand 2-inch rock bass were obtained for distribution to applicants in Arkansas and Louisiana. The stock of 232 adult smallmouth bass on hand began spawning on April 13, somewhat later than usual. The fry grew rapidly, however, and 121,000 were taken from the ponds before the close of the fiscal year and shipped to applicants. The year's production of largemouth bass, though not as large as the crop of young smallmouth bass, was fairly successful. The brood stock of 440 fish included many that were not fully matured, and such fish always produce smaller than the usual brood. Approximately 80,000 young largemouth bass had been distributed at the close of the year and a large number still remained in the pond. The output from this station also included a considerable number of bream and limited numbers of crappie and catfish.

The dry weather and consequent low-water stages in many of the streams in this region resulted in a material diminution of the supply of native game fishes in public waters.

Orangeburg (S. C.) Station

[G. W. N. Brown, Superintendent]

Owing to a combination of unfavorable natural conditions the output of black bass from this station was small as compared with the records of former years. The unusually cold weather predominating during February and early March unduly retarded the spawning season, and the prevalence of cold, backward weather late in March after spawning had begun caused many of the parent fish to desert their nests. It was observed in a number of instances that brood fish were abandoning their nests after the fry had hatched, leaving them prey to other fishes. Another contributing factor to the small output was the existing drought, the water supply at one time being so low that there was no current to carry the sediment out of the ponds.

The bream shown in the tables of output were carried over from the hatch of the preceding year and distributed to applicants as large-sized fingerlings. At the close of the year it was impossible to form any accurate estimate of the current season's hatch of bream. In addition to the output of bass and bream, the station produced and distributed small numbers of warmouth bass, crappie, and spotted catfish.

San Marcos (Tex.) Station

[O. N. Baldwin, Superintendent]

Of the six species of pond fishes propagated at this station the largemouth black bass is the most important. At the opening of the fiscal year 270 brood fish of that species were on hand in the station ponds, most of them being of rather small size. This stock was increased later to 480 by the addition of wild bass captured in local waters. In advance of the spawning season the fish were apportioned among the 14 breeding ponds devoted to the work, and on

March 15 the first fry of the season were observed. A large yield was assured by weather and water conditions, which were generally favorable throughout the season, and the output, amounting to 346,100, exceeded that of the previous year by 124,000. In accordance with past custom all of the fish were reared to the fingerling stage before shipment, the output including many thousands that ranged from 3 to 4 inches long when distributed. The station produced comparatively small numbers of rock bass, bream, and warmouth bass, while considerable numbers of such fishes were rescued from overflowed lands of the region and returned to their native waters.

With the view of establishing a source of supply for crappie for distribution to applicants, 275 brood fish of that species were collected from the Colorado River at Austin Dam during the winter and placed in tanks or ponds belonging to ranchmen in the vicinity of San Marcos. While none of the resulting fry had been distributed at the close of the year, several tests with seines indicated that good results might be expected later. In addition to the station output of pond fishes a considerable number of black bass was produced and distributed from the pond auxiliaries situated at Medina Lake and New Braunfels, Tex.

Tupelo (Miss.) Station

[C. R. Wiant, Superintendent]

At the opening of the spawning period, in the spring of 1926, the ponds at Tupelo station were carrying a brood stock of 458 largemouth black bass and all prospects seemed good for a large production of young fish of that species. This outlook was changed by the occurrence on March 24 of a sudden cold spell that covered two-thirds of the pond area with a one-fourth inch layer of ice. Under such conditions all of the fish abandoned their nests and the eggs deposited in them were lost. Another cold spell late in April not only resulted in the destruction of all eggs in the ponds at the time but it was followed by a period of storms and wind that roiled the pond water to such an extent as to cause very unfavorable nesting conditions. Taken as a whole, the weather during the bass spawning season was the most adverse ever encountered in the fish-cultural work at this point, but notwithstanding this fact the station's output of bass (aggregating 435,730, of which 73,230 were fingerling fish), was the third largest in its history.

A new method of procedure in the propagation of the bluegill bream was put into effect in advance of the spawning of that species. During June and July, after virtually all of the young black bass had been removed from the ponds, these ponds were stocked with adult bream collected from neighboring lakes, from 35 to 50 breeders being placed in each inclosure. The result was a decided success, the year's distributions of young bluegills totaling 200,150, more than double the record of any previous year. The year's work at this station also included the production of a comparatively small output of crappie and rock bass.

A considerable amount of improvement work was accomplished during the year, such work including the construction of one new pond 1½ acres in area.

Lakeland (Md.) Ponds Substation

[Supervised by Washington office of fish culture]

Early in the spring of 1925 four of the five ponds constituting this system were stocked with adult fish, one with largemouth black bass, one with smallmouth black bass, one with bream, and one with crappie. The prevalence of cold, unseasonable weather during the spawning period curtailed the results materially. Early in July, 3,405 fingerling fish seined from along the shores of the largemouth-bass pond, were distributed to applicants. During the first half of August large numbers of the fingerling fish in this pond were observed to come in close to the shore line, many in a dying condition, and all of them apparently distressed. An examination of the water showed it to be thick with some substance (afterward diagnosed as algæ of special species) that virtually covered the entire surface of the pond. About 2,000 of the fingerlings removed from the pond were placed in fresh water, where they revived immediately. When this pond was drained, later in the season, no live fingerling fish were found, and all of the adults were in very poor condition.

For some reason the smallmouth bass did not spawn to any appreciable extent, and only about twenty-five 4-inch fingerlings were found in their pond when it was drained. The yield of crappie amounted to 3,825 fingerling fish, Many of this species were lost through the development of algæ, which was just beginning to spread at the time the pond was drawn in early October.

CENTRAL STATION AND AQUARIUM, WASHINGTON, D. C.

[L. G. Harron, Superintendent]

Earnest efforts were put forth during the year to maintain a creditable display of aquatic life in the aquarium, but it proved almost impossible at times owing to the almost constant use of chlorine in the city water supply. During the period from August 15 to January 1, when the water was almost free of chlorine, no difficulty was experienced in maintaining an attractive exhibit. During the last week of December, however, the reappearance of bacteria in the city supply again necessitated the use of chlorine in large quantities. There were on display at that time about 4,300 chinook-salmon fry and 18,500 rainbow-trout eggs just at the point of hatching. The eggs were at once turned over to the Maryland fish commission, but the fry succumbed to the effects of the chemical before any steps could be taken to dispose of them. Other species of fish eggs, including whitefish, cisco, and pike perch, were received later and successfully incubated. During the year 1,453 fish and aquatic animals, representing 33 species, were carried in the aquarium.

Part 2.—DISTRIBUTION OF FISH AND FISH EGGS

[E. C. Fearnow, Superintendent of Fish Distribution]

In distributing the year's output of 5,232,373,000 fish and fish eggs from the various stations of the bureau, trips were made to all parts of the United States; fish eggs were sent to the Governments of Canada, Argentina, Brazil, Colombia, Italy, Switzerland, and Japan, and one shipment of top minnows (*Gambusia affinis*) was forwarded to Santo Domingo. As usual, about 95 per cent of the year's output consisted of eggs and fry of the commercial fishes, and all of these except the comparatively few supplied to State fisheries authorities were planted in the waters from which the eggs were derived. The fishes included in this classification are the shad, glut herring, whitefish, cisco, the salmons, pike perch, yellow perch, carp, buffalo fish, cod, haddock, pollock, and winter flounder. The species mostly propagated for stocking interior waters are the brook, rainbow, blackspotted, and Loch Leven trouts, the largemouth black bass, smallmouth black bass, crappie, rock bass, bream, and catfish. While the number of fish of such species produced is comparatively small, representing only about 7 per cent of the entire output, it is this branch of the work that brings the bureau in close contact with the general public, making it relatively important, because public interest in the fisheries is an influence that can not be considered to be otherwise than beneficial.

The work connected with the distribution of fish is very heavy, in numerous instances necessitating long and laborious overtime duty. It is also quite hazardous, involving almost constant travel, and the salaries provided are much lower than those paid for similar work outside the Government service. Resignations submitted during the past year made it necessary to appoint three car messengers, two assistant messengers, and five car cooks. These changes, together with those involved in the transfer of two members of the distribution force to positions at fish-cultural stations of the bureau, constituted a turnover of 50 per cent in the car service personnel in the course of the fiscal year 1926.

The following table shows in summarized form the distribution of fish and fish eggs during the fiscal year to applicants in the United States and its territories. It also shows plants of fish made on the bureau's initiative in the public waters of the country in connection with the propagation of the commercial fishes and the salvage of fish from temporarily flooded lands. The output of the hatcheries that handle the commercial fishes is planted, so far as practicable, on the natural spawning grounds from which the eggs are derived, this course being essential for the maintenance of the fisheries, especially in regions where commercial fishing is prosecuted extensively and also in the case of the anadromous fishes. The activities of the commercial fishermen are coincident with the spawning period of the fish. Almost all salvaged fishes are returned to their native waters, only a very small percentage being used for filling applications.

Summary, by species, of distribution of fish, fiscal year 1926

State and species	Number
Alabama:	
Catfish	4,925
Largemouth black bass	258,300
Sunfish	51,290
Alaska: Sockeye salmon	55,297,000
Arizona:	
Catfish	52,700
Brook trout	40,000
Crappie	16,660
Largemouth black bass	2,517
Sunfish	3,400
Yellow perch	2,350
Arkansas:	
Catfish	1,457
Rainbow trout	6,375
Crappie	1,450
Largemouth black bass	82,790
Smallmouth black bass	112,225
Rock bass	11,600
Sunfish	31,700
Yellow perch	100
California: Chinook salmon	6,152,700
Colorado:	
Catfish	800
Steelhead salmon	24,150
Rainbow trout	179,570
Black-spotted trout	266,500
Loch Leven trout	174,000
Lake trout	101,000
Brook trout	2,781,500
Crappie	330
Largemouth black bass	7,010
Rock bass	800
Sunfish	1,800
Yellow perch	200
Connecticut:	
Rainbow trout	2,000
Brook trout	10,200
Pike perch	1,400,000
Yellow perch	65
Delaware:	
Crappie	600
Largemouth black bass	112
Sunfish	1,200
Yellow perch	65
District of Columbia:	
Crappie	125
Largemouth black bass	40
Pike perch	100,000
Florida: Largemouth black bass	2,000
Georgia:	
Catfish	3,200
Rainbow trout	35,800
Brook trout	42,000
Crappie	60
Largemouth black bass	219,857
Warmouth bass	60
Sunfish	123,030
Yellow perch	116
Idaho:	
Chinook salmon	12,724,000
Steelhead salmon	79,000
Rainbow trout	127,000
Black-spotted trout	164,900
Loch Leven trout	8,000
Brook trout	4,160
Illinois:	
Catfish	3,800
Crappie	10,575
Largemouth black bass	7,485
Sunfish	12,450
Yellow perch	200
Miscellaneous fishes	6,087,809
Indiana:	
Catfish	9,150
Brook trout	20,000
Crappie	6,640
Largemouth black bass	10,370
Smallmouth black bass	90,100
Sunfish	21,375
Yellow perch	3,000

State and species	Number
Iowa:	
Catfish	13,030,909
Buffalo fish	9,055,445
Carp	15,599,600
Rainbow trout	30,050
Loch Leven trout	2,000
Brook trout	11,000
Pike and pickerel	65,950
Crappie	8,678,855
Largemouth black bass	34,599
Sunfish	8,542,995
Yellow perch	130,755
Sheepshead	278
White bass	835
Drum	4,840
Miscellaneous fishes	1,092,536
Kansas:	
Crappie	1,100
Largemouth black bass	4,700
Sunfish	800
Yellow perch	384
Kentucky:	
Catfish	1,000
Lake trout	29,000
Largemouth black bass	2,253
Smallmouth black bass	597,000
Rock bass	2,250
Sunfish	15,700
Louisiana:	
Catfish	400
Buffalo fish	105,315,000
Rock bass	4,300
Sunfish	20,100
Maine:	
Humpback salmon	998,900
Landlocked salmon	554,155
Brook trout	1,119,880
Crappie	600
Largemouth black bass	100
Smallmouth black bass	2,455
Flatfish	1,487,438,000
Maryland:	
Rainbow trout	23,950
Loch Leven trout	1,500
Brook trout	7,200
Crappie	1,500
Largemouth black bass	1,393
Smallmouth black bass	60
Sunfish	1,000
Yellow perch	50
Massachusetts:	
Steelhead salmon	1,500
Landlocked salmon	125,000
Rainbow trout	1,080
Brook trout	19,263
Mackerel	2,067,000
Smallmouth black bass	1,660
Pike perch	1,155,000
Cod	558,662,000
Haddock	31,895,000
Pollock	428,778,000
Flatfish	828,727,000
Michigan:	
Catfish	1,400,000
Whitefish	44,800,000
Steelhead salmon	39,500
Rainbow trout	94,500
Lake trout	25,712,000
Brook trout	665,501
Crappie	3,000
Largemouth black bass	600
Smallmouth black bass	148,350
Sunfish	3,200
Pike perch	2,475,000
Minnesota:	
Catfish	1,226,150
Buffalo fish	139,870
Carp	2,795,915
Rainbow trout	68,100
Loch Leven trout	48,320
Lake trout	1,941,500

Summary, by species, of distribution of fish, fiscal year 1926—Continued

State and species	Number
Minnesota—Continued.	
Brook trout	139,100
Pike and pickerel	154,630
Crappie	9,741,215
Largemouth black bass	119,775
Sunfish	6,415,703
Yellow perch	2,248,250
White bass	13,105
Fresh water drum	97,175
Miscellaneous fishes	989,850
Mississippi:	
Crappie	155
Largemouth black bass	346,305
Warmouth bass	1,000
Sunfish	180,950
Missouri:	
Catfish	12,550
Rainbow trout	141,020
Crappie	7,564
Largemouth black bass	15,600
Rock bass	1,500
Sunfish	25,913
Yellow perch	207
Montana:	
Rainbow trout	1,718,600
Black-spotted trout	1,514,724
Loch Leven trout	577,575
Brook trout	528,430
Grayling	4,823,800
Nebraska:	
Rainbow trout	31,250
Loch Leven trout	32,400
Brook trout	152,900
Crappie	500
Largemouth black bass	595
Sunfish	1,000
Yellow perch	375
Nevada:	
Rainbow trout	46,200
Black-spotted trout	8,400
Brook trout	70,350
New Hampshire:	
Landlocked salmon	500
Rainbow trout	61,000
Loch Leven trout	17,800
Brook trout	906,966
Pike perch	175,000
New Jersey:	
Catfish	90
Rainbow trout	500
Brook trout	1,800
Crappie	3,180
Largemouth black bass	7,945
Sunfish	4,850
New Mexico:	
Catfish	2,200
Steelhead salmon	14,500
Black-spotted trout	40,000
Brook trout	8,750
Crappie	490
Largemouth black bass	2,195
Rock bass	200
Sunfish	1,700
New York:	
Whitefish	40,400,000
Lake herring	84,700,000
Rainbow trout	104,000
Loch Leven trout	68,540
Lake trout	1,671,500
Brook trout	466,560
Crappie	5,750
Largemouth black bass	2,155
Smallmouth black bass	465
Sunfish	3,001
Pike perch	3,300,000
Yellow perch	280,540
Flatfish	18,069,000
North Carolina:	
Catfish	1,700
Glut herring	30,000,000
Rainbow trout	87,780
Brook trout	202,000

State and species	Number
North Carolina—Continued.	
Crappie	4,742
Largemouth black bass	207,732
Rock bass	4,400
Warmouth bass	650
Sunfish	38,535
Yellow perch	1,500,040
North Dakota:	
Catfish	2,550
Crappie	4,625
Largemouth black bass	1,245
Sunfish	7,500
Yellow perch	4,125
Ohio:	
Catfish	3,450
Carp	54,500,000
Whitefish	107,924,000
Rainbow trout	20,500
Brook trout	60,000
Crappie	5,200
Largemouth black bass	12,280
Smallmouth black bass	64,000
Sunfish	10,145
Pike perch	135,320,000
Yellow perch	7,592,050
Oklahoma:	
Catfish	4,600
Rainbow trout	10,280
Loch Leven trout	42,000
Crappie	4,140
Largemouth black bass	27,930
Rock bass	290
Sunfish	5,430
Yellow perch	225
Oregon:	
Chinook salmon	9,439,000
Silver salmon	2,559,800
Steelhead salmon	1,713,475
Rainbow trout	10,000
Brook trout	153,300
Silver trout	65,500
Pennsylvania:	
Catfish	16,520
Rainbow trout	201,450
Loch Leven trout	112,200
Brook trout	1,134,750
Crappie	21,107
Largemouth black bass	25,655
Sunfish	46,225
Yellow perch	9,435
South Carolina:	
Catfish	35
Rainbow trout	31,000
Brook trout	45,400
Crappie	524
Largemouth black bass	46,475
Warmouth bass	1,100
Sunfish	27,670
South Dakota:	
Rainbow trout	32,200
Loch Leven trout	163,100
Brook trout	1,146,350
Tennessee:	
Catfish	8,800
Rainbow trout	41,900
Brook trout	51,350
Crappie	8,000
Largemouth black bass	83,285
Sunfish	41,617
Yellow perch	1,694
Texas:	
Catfish	5,602
Steelhead trout	5,500
Rainbow trout	9,220
Crappie	28
Largemouth black bass	427,266
Smallmouth black bass	3,000
Rock bass	5,315
Warmouth bass	1,769
Sunfish	66,533

Summary, by species, of distribution of fish, fiscal year 1926—Continued

State and species	Number
Utah:	
Catfish	24,200
Rainbow trout	530,775
Black-spotted trout	28,800
Brook trout	478,600
Vermont:	
Steelhead salmon	103,000
Landlocked salmon	9,522
Loch Leven trout	40,000
Rainbow trout	17,000
Lake trout	56,800
Brook trout	1,018,432
Smallmouth black bass	39,000
Pike perch	5,900,000
Yellow perch	17,150,000
Virginia:	
Rainbow trout	173,468
Brook trout	251,750
Crappie	2,403
Largemouth black bass	247,602
Smallmouth black bass	32,600
Rock bass	6,410
Sunfish	15,465
Washington:	
Chinook salmon	38,577,265
Silver salmon	7,193,050
Sockeye salmon	11,827,980
Humpback salmon	844,600
Steelhead salmon	2,443,250
Rainbow trout	37,600
Black-spotted trout	6,300
Brook trout	180,000
West Virginia:	
Catfish	8,850
Rainbow trout	495,836
West Virginia—Continued.	
Loch Leven trout	163,500
Brook trout	1,055,409
Crappie	400
Largemouth black bass	86,907
Rock bass	6,400
Sunfish	1,300
Pike perch	600,000
Yellow perch	1,625
Wisconsin:	
Catfish	11,672,325
Buffalo fish	1,153,600
Carp	15,257,000
Rainbow trout	169,300
Loch Leven trout	135,860
Lake trout	977,500
Brook trout	669,950
Pike and pickerel	84,690
Crappie	4,525,315
Largemouth black bass	85,615
Smallmouth black bass	5,000
Rock bass	200
Sunfish	11,039,445
Pike perch	13,842,200
Yellow perch	368,971
White bass	25,938
Drum	21,425
Miscellaneous fishes	5,125,933
Wyoming:	
Catfish	100
Rainbow trout	154,100
Black-spotted trout	2,847,000
Loch Leven trout	384,800
Brook trout	962,102
Black bass	210

METHOD OF DISTRIBUTION

In connection with its work of supplying fish on the 12,000 to 15,000 applications received every year, the bureau aims to so apportion the output of its hatcheries as to obtain the maximum results, giving special consideration to waters in which the fish planted will have an opportunity to mature and reproduce. In pursuance of this plan many difficulties are encountered, not the least of them being the frequent insistence of an applicant to obtain some favorite species of fish regardless of whether or not the waters he desires to stock are suitable therefor. The bureau, of course, refuses to furnish fish for waters to which they are not adapted, but it is often difficult to convince an applicant of the wisdom of this policy.

Requests for fish of the warm-water species, especially the largemouth and smallmouth black bass, have increased to such an extent within recent years that the present outlook for satisfying the demand does not appear hopeful. In the past the bureau has relied largely on the collecting fields along the Mississippi River for its stock of largemouth black bass for supplying applicants residing in States where no Federal bass hatcheries are operated, but within recent years such collections in the rescue fields have been comparatively small, sometimes not exceeding 500,000 in a season. As a large percentage of the bass collected must be returned to their native waters for the maintenance of the supply, it can readily be understood that this source is not dependable and that great necessity exists for the establishment of additional sources of supply for black bass, especially in the east and the midwest, if the demands for this

fish are to be met. Within recent years the output of smallmouth bass at hatcheries in the east has been almost negligible.

Very little difficulty is experienced in producing the various species of trout in sufficient numbers to meet requirements, owing to the fact that they can be hatched artificially and fed on beef liver or other food until they attain fingerling size; but this is different with the basses. These fish prefer live food; they must be allowed to reproduce under more or less natural conditions in specially prepared ponds, and the output of a season depends largely upon climatic conditions prevailing during the spawning season.

COST OF DISTRIBUTION

In recent years the office of distribution has economized to the utmost, and if the constantly increasing demands for fish are to be satisfied, additional funds must be provided. Before the World War as much as $80,000 was expended in distributing the bureau's annual output of fish and fish eggs. That the cost of distribution can not be reduced below the amount at present allowed is evidenced by the heavy shipments that are now being carried to a trip. With the view of accomplishing as much work as possible on the allotment provided, messenger shipments in baggage cars have been made exceedingly heavy. In 1914, at a time when the cost of everything entering into the work was comparatively low, the year's output of 4,047,643,417 fish and fish eggs was distributed at a cost of $68,399.93. The past fiscal year's output of 5,232,373,000 fish and eggs—more than 1,000,000,000 in excess of the output in 1914—was distributed for $58,000, approximately $10,000 less than the amount expended in 1914.

In 1926 the bureau honored 13,118 applications for fish and made deliveries on 12,000 applications. In making the distributions the cars traveled 84,600 miles and the detached messengers 403,000 miles.

In distributing the fish produced at the bureau's stations the principal part of the cost involved is in the shipment of the fingerlings intended for stocking interior waters. The expense of distributing the output of stations handling marine and anadromous species and the fishes of the Great Lakes region is comparatively small. The records show that in 1914 the output of the most expensive fishes to distribute—landlocked salmon, rainbow trout, brook trout, largemouth black bass, and smallmouth black bass—aggregated only a little more than 24,000,000, while in 1926 nearly 40,000,000 of such fishes were shipped. Furthermore, the trout distributed in 1926 were larger in the main than those distributed in any previous year in the bureau's history.

The cost of distributing one thousand 4-inch fish is at least five times greater than the amount involved in distributing an equal number of fry; but, on the other hand, the stocking value of the larger size is estimated to be ten times greater than that of the same number of fry. In view of this fact it is advisable to rear as many of the fish as possible to the stage where they will be able to care for themselves in their new environment, even though it costs more to distribute them. In fact, it would be good policy to limit the output of all cooperative stations to the number of fish that can be reared to a length of 3 or 4 inches before disposing of them.

While recent improvements to the distribution cars and their equipment have almost doubled their carrying capacity, it has not been possible to reduce the cost of maintenance or the cost of repairs. Out of every $5 expended in the distribution of fish by the cars, $2 must be applied to maintenance and repairs. This leaves only about 60 per cent of the allotment for travel, subsistence, and incidentals. It is out of this 60 per cent that any savings must be effected.

The cooperative stations were not prepared to receive fish at the time when transfers could have been made most economically, hence the fish had to be carried at the rate of 400 or 500 to the can. Had it been possible to ship them in March or April, 1,500 fish could have been carried in a can.

ALLOTMENT OF FISH TO APPLICANTS

In alloting fish to applicants, the bureau considers (1) the available stock of the species assigned, (2) the size of the fish at the time the distribution is made, (3) the number of applications to be filled, (4) the extent of the water area to be stocked, and (5) the distance involved in making the delivery. It endeavors in every case to furnish a sufficient number of young fish for the establishment of a brood stock, and the recipient is expected to see that the fish are furnished adequate protection until they have had time to mature and stock the waters through natural reproduction. While it is recognized that large bodies of water should receive more fish than smaller ones, it does not seem wise to honor applications for large water areas to the exclusion of smaller though perhaps not less important waters. It is the policy to apportion the output of the bureau's hatcheries in such a manner as will permit the filling of all applications listed. Requests for fish frequently are received from individuals living in sections remote from a fish-cultural station and in a region whose waters already abound with desirable fishes. In a case of that kind the bureau does not consider it proper to incur the expense of sending a small number of hatchery-reared fish to an applicant and he is notified to that effect.

TIME OF DELIVERY

It is the policy of the bureau to fill applications in the order of their receipt and to deliver the assigned fish as soon as possible thereafter. Certain phases of the distribution work, however, should be thoroughly understood in advance by prospective applicants.

The high cost of shipping fish compels the bureau to exercise rigid economy in planning the work of its cars and messengers. The delivery of fish to an applicant remotely situated can not be made until a sufficient number of applications have been received from that section of the country to warrant the expense of making a messenger shipment. The bureau can not carry a stock of fish for delivery on demand, and when the supply of one year is exhausted all unsupplied applicants must wait until the succeeding year's output is available. Trout shipments from the bureau's eastern stations begin in March, and all applications from the Eastern States received after the 1st of March are carried on file for attention the

following year. Trout are distributed from stations in the Rocky Mountain region from May to October, and in order to insure early delivery applications from that section should be submitted prior to May 1. Applications for such warm-water fishes as bass, sunfish, and crappie should be submitted prior to May 1, as such species are shipped between May and December.

Fish are shipped in railroad cars especially designed for the purpose or in baggage cars accompanied by messenger, and delivery is made at the applicant's railroad station free of cost to him. On the receipt of an application for fish the applicant is immediately notified as to the species assigned thereon and the approximate time of delivery. Full directions as to the manner of receiving and caring for the fish also are furnished him. Shortly before shipment is made a second notice is sent, specifying the exact time when the consignment will arrive at the applicant's railroad station. If for any reason the delivery must be postponed, the applicant is duly notified.

DISTRIBUTION CARS

Of the five specially equipped cars operated by the bureau in the transportation of live fish, three are of steel construction and two of wood. Owing to the increased carrying capacity of the steel cars, which is approximately two-thirds greater than that of the wooden ones, it has frequently been urged on the ground of economy and efficiency, that the wooden cars be replaced with cars of steel construction. The railroad companies object to hauling wooden cars in their best trains, and as a matter of fact it would be dangerous to place a wooden car between two steel coaches even though it were equipped with the electrical connections required on cars carried in modern trains. Furthermore, a car of wood construction is not allowed to pass through the tube under the Hudson River. In view of the foregoing, the saving in transportation and maintenance costs involved in the substitution of all-steel cars is obvious. In the interest of economy and efficiency, it may be stated, to insure the successful transportation of live fish they must be moved expeditiously. Any considerable delay en route not only disarranges the whole itinerary of a trip and necessitates the expense of telegraphing to a hundred or more applicants, but in many instances it results in the loss of fish.

CAR NO. 3

[E. R. Widmyer, Captain]

At the beginning of the fiscal year 1926 the Fearnow pails on this car were overhauled, cleaned, and restenciled; the aerating equipment of the car was repaired and its pumps and machinery placed in good condition.

The distribution of warm-water fishes from the La Crosse (Wis.) station was taken up on August 13, at which time a carload shipment of fish was made to Milwaukee, Wis. During August and the three succeeding months the car made 11 trips from Mississippi River stations, carrying from 156 to 201 pails of fish to a trip. In addition to this travel a number of messenger shipments were made to points in Wisconsin, Minnesota, Iowa, Illinois, and Michigan. In the course of the season the car and its crew carried from the Mississippi River stations and delivered to applicants a total of 227,155 fingerling fish, of which 56,960 were black bass, 64,835 crappie, 46,745 bream, 25,775 yellow perch, and 32,740 catfish.

In late November, after the close of the distribution season in the rescue field, the car was transferred to Milwaukee, Wis., to undergo annual repairs, and its crew was detailed to fish-cultural stations of the bureau for the winter months. The car was held in the coach yards of the Chicago, Milwaukee & St. Paul Railway Co. from December 1 until early in January, when it was sent to the repair shops. On the completion of the repairs the car was returned to the coach yards and held until April 26, when it proceeded to La Crosse, Wis., at which point its equipment was overhauled preparatory to taking up the spring distributions. The car left La Crosse on May 23 with 59,900 brook trout, 22,500 Loch Leven trout, and 10,000 rainbow trout, all fingerlings, for delivery to applicants in Wisconsin and Minnesota. After completing this trip it proceeded to the Duluth (Minn.) station to distribute the season's output of lake trout and whitefish, and during the remaining days in May and early June the crew planted and delivered 16,290,000 pike-perch fry, 1,400,000 whitefish fry, 8,812,000 lake-trout fry, and 129,600 fingerling brook trout. On the completion of the Duluth distributions the car proceeded to the Manchester (Iowa) station, arriving there June 11. After moving 105,700 fingerling brook, rainbow, and Loch Leven trout from this station to Minocqua, Wis., the car returned to La Crosse and remained there until June 28, when it again arrived at Manchester and took on a load of fingerling trout for delivery to Wisconsin applicants. While stationed at La Crosse messenger shipments of fingerling trout aggregating 87,100 were delivered by members of the crew to applicants in Minnesota and Wisconsin.

During the fiscal year 1926 the car traveled 14,982 miles and carried 227,315 fingerling pond fishes, 16,290,000 pike-perch fry, 1,400,000 whitefish fry, 8,812,000 lake-trout fry, 307,800 fingerling brook trout, 55,000 fingerling rainbow trout, and 33,600 fingerling Loch Leven trout, a total of 27,125,715 fish.

CAR NO. 4

[F. W. A. ENGELHARDT, Acting captain]

Car No. 4 was at Portland, Me., at the beginning of the fiscal year, having just completed the distribution of trout from the Craig Brook (Me.) hatchery. It left there on July 3 for Nashua, N. H., at which point it remained until August 14 while its crew made messenger shipments of trout to various points in New Hampshire, Connecticut, and Massachusetts. On August 15 the car proceeded to Washington, D. C., with a consignment of brook trout for stocking cooperative nursery projects at Myersdale and Uniontown, Pa., the deliveries being made by messenger from Washington. One member of the crew was detailed to distribute trout from the Watertown (N. Y.) substation, and the remainder of the force was assigned to the distribution of fish from the Lakeland (Md.) ponds. The car was ordered to Dubuque, Iowa, on October 24 to assist in the distribution work from the Mississippi River collecting stations. It made carload shipments of fish from that field to Nashua, Iowa; Cookeville, Tenn.; Harrisburg, Pa; and Washington, D. C., arriving at the last-named destination on November 30. The car was then sent to the shops of the Pennsylvania Railroad Co. at Wilmington, Del., for annual repairs, and the members of its crew were detailed to the Washington office for duty during the winter.

On the last day of March Car No. 4 left Washington to take up the distribution of trout from the White Sulphur Springs (W. Va.) station. Messenger shipments were made to points in Virginia and West Virginia, and carload shipments of trout were forwarded to Elkins, W. Va. (two trips), Altoona, Philipsburg, Uniontown, Windber, and Philadelphia, Pa. From Philadelphia the car went to Nashua, N. H., and obtained a carload of trout for distribution en route to Bucksport, Me., to take up the trout and salmon distribution work from the Craig Brook (Me.) hatchery. Carload shipments were made from Bucksport to Calais (two trips), Kineo, Mattawamkeag, Blanchard (two trips), Dover, Foxcroft, Houlton, and Waterville, Me. The car then returned to the Nashua station, arriving there June 26. Messenger shipments were made from Nashua.

In the course of the fiscal year the car made 27 trips, traveled 15,030 miles, and delivered 3,700 pails of fish, supplying 1,119 applicants.

Species and size of fish delivered by car No. 4

Species	Fry	Fingerlings No. 1	Fingerlings No. 2	Fingerlings No. 3	Fingerlings No. 4	Yearlings	Adults
Catfish				5,750	1,900	900	750
Atlantic salmon	776,000	125,637					
Landlocked salmon	136,000	103,000		151			
Rainbow trout		112,300	82,900				
Loch Leven trout		82,300		400	400	1,340	
Brook trout	481,600	1,172,500	12,600			2,250	
Grayling							5
Crappie			5,850	6,975	2,600		
Largemouth black bass				2,510	2,830	1,147	255
Smallmouth black bass					425		
Sunfish			3,240	410		750	490
Yellow perch				4,800			
Total	1,393,600	1,595,737	104,590	20,996	8,155	6,387	1,500

CAR NO. 7

[E. M. LAMON, Captain]

Car No. 7 arrived at Bozeman, Mont., on July 1 and immediately undertook the distribution of trout. Messenger trips were made to nearby points, and carload shipments of fish were forwarded to Glacier Park and Lewistown, Mont., and Casper, Wyo. The car and its crew were then detailed to work under the direction of the Montana Fish and Game Commission, and from July 23 to the end of August, 12 carload shipments aggregating 2,405,000 black-spotted and rainbow trout were transported from State hatcheries at Emigrant, Anaconda, Missoula, Hamilton, and Great Falls, Mont., and distributed at various points in that State. The car resumed its work from the Bozeman station on September 1, making trips to Spokane, Wash.; Lander, Wyo.; and Dubuque, Iowa. In the course of the season, 302,500 brook trout, 416,000 rainbow trout, 186,500 black-spotted trout, 53,000 Loch Leven trout, and 6,000 landlocked salmon were distributed from Bozeman. En route from Bozeman to Dubuque applicants in Wyoming and Wisconsin were supplied, and 24 adult grayling and 19 black-spotted trout were delivered for the aquariums at Lincoln Park, Chicago, Ill., and Central Station, Washington, D. C. The car reached Dubuque on September 28, and after completing its deliveries of fish it was placed in the Chicago, Milwaukee & St. Paul Railway Co. shops for minor repairs.

The distribution work from the upper Mississippi River rescue stations was taken up on October 5. In the course of trips made to Union City and Philadelphia, Pa.; Tuscaloosa, Ala.; Knoxville, Tenn.; Fort Wayne, Ind.; and St. Louis, Mo., 109,000 fingerling pond fishes were distributed by the car and its messengers in the States of Pennsylvania, Alabama, Tennessee, Indiana, Missouri, New Jersey, Maryland, and Ohio. In connection with the trip to Philadelphia the car took on 20,000 fingerling brook trout from a commercial hatchery at Mauch Chunk, Pa., and delivered them to the Northville (Mich.) station of the bureau. On the completion of the distributions in the rescue field early in December the car was placed in the railway shops at Dubuque for general repairs and its crew was detailed for duty during the winter at various fish-cultural stations of the bureau.

On May 5 the car took on at the Manchester (Iowa) station a load of 36,400 rainbow trout, 65,000 brook trout, and 30,500 Loch Leven trout for delivery at Madison, Wis. From Madison it returned to La Crosse, and between May 9 and May 29 it received from the La Crosse station and distributed to applicants in Wisconsin and Minnesota 115,000 rainbow trout, 402,000 brook trout, and 85,000 Loch Leven trout. On the completion of this work it proceeded to the Northville (Mich.) station, and on June 12 transported a load of brook trout from that point to Hillman, Mich., for the Turtle Lake Club. Returning to Northville on the completion of this trip, a number of messenger shipments of trout and smallmouth black bass were made by its crew, supplying applicants in Michigan, Indiana, and Ohio. The numbers and species of fish distributed during the year are shown in the following table:

Species	Fry	Fingerlings	Yearlings	Adults
Catfish		7,000	500	80
Landlocked salmon		6,000		
Rainbow trout		735,600		
Black-spotted trout		2,350,500		19
Loch Leven trout		124,500		
Brook trout		778,200	7,240	
Grayling				24
Crappie		25,075	926	
Largemouth black bass		20,800	630	28
Smallmouth black bass	227,500			
Sunfish		18,250	1,960	195
Yellow perch		4,860		12
Total	227,500	4,070,785	11,256	358

During the year the car made 34 trips and traveled 23,944 miles, while messengers operating from the car made 100 trips and traveled 28,387 miles.

CAR NO. 8

[E. K. BURNHAM, Captain]

In the course of the year car No. 8 distributed fish from the upper Mississippi River rescue field and from the Neosho (Mo.), Langdon (Kans.), and Leadville (Colo.) stations. It carried 13 carload lots of fish, traveled 7,041 miles over eight railroads, sent out 50 side trips, and delivered 777,522 fish in 10 States. The following table shows the species and numbers of fish handled:

Species	Fingerlings	Yearlings	Adults
Catfish	6,500		
Steelhead salmon	30,000		
Rainbow trout	91,320		
Black-spotted trout	181,000		
Brook trout	416,750		
Crappie	2,465	3,430	
Largemouth black bass	37,960	25	
Rock bass	1,550		
Sunfish	5,000	330	408
Yellow perch	784		
Total	773,329	3,785	408

In addition to the 50 side trips made from the car, its messengers made 32 trips with fish from the hatcheries, distributing an aggregate of 576,395 fingerling catfish, steelhead salmon, rainbow, black-spotted, and brook trout, crappie, largemouth black bass, sunfish, and yellow perch, at a total cost of $1,861.40.

The crew of the car made all needed minor repairs to its interior during the year and maintained all of its railroad appurtenances in accordance with existing traffic regulations, such work being accomplished at a moderate cost. One of the most valuable changes effected by the crew was the arrangement of the piping in the boiler room, so that water from the boiler may be drawn by the injector through pipes coming from the pressure tanks on each side of the car and also from the tanks above the kitchen. These three sources of supply assure enough water to operate the boiler at all times.

A very simple but at the same time a most satisfactory improvement was made by the railroad company. It consisted in the installation of hardwood shims under the equalizing springs of the car, which allow the car to balance perfectly and ride much more smoothly than it has in the past.

CAR NO. 9

[H. F. JOHNSTON, Captain]

Early in July, 1925, this car was stationed at Washington, D. C., while the members of its force were engaged in making messengers shipments with black bass from the Lakeland (Md.) ponds to applicants in Maryland, Virginia, and New Jersey. On July 24 the car proceeded to the White Sulphur Springs (W. Va.) station and obtained a carload of fingerling rainbow trout for stocking waters in the vicinity of Cass, W. Va. Upon arrival at Cass the entire load of fish was transferred to a logging railroad and transported 35 miles into the mountains, to be planted in streams near the headwaters of the Elk River. From Cass the car returned to White Sulphur Springs and distributed another load of trout to applicants in the vicinity of Williamsport, Pa.

Shortly after the middle of August this car was assigned to the work of distributing black bass and miscellaneous fishes from the various rescue stations along the Mississippi River. As a result of its activities in that field, which extended into the last week in November, 56,662 black bass, 10,599 yellow perch, 50,205 bream, 29,200 catfish, and 48,275 crappie were distributed to applicants in Wisconsin, Tennessee, Ohio, Indiana, Pennsylvania, New Jersey, and New York. The car also made a trip from Homer, Minn., to Globe, Ariz., with a load of fingerling black bass, crappie, catfish, yellow perch, and sunfish for deposit in the Roosevelt Reservoir at that point. On November 24 the car returned to Washington, D. C., and the members of its crew were detailed for winter duty at fish-cultural stations of the bureau. Annual repairs were made in December at the Pennsylvania Railroad Co. shops at Wilmington, Del., and after their completion the car was utilized as living quarters for such members of the distribution force as were detailed to the Washington office of the bureau.

With the view of taking up the spring distribution of trout from the Erwin (Tenn.) station, the car left Washington on April 1, proceeding via Government Siding, Va., where it took on a load of fingerling brook trout and distributed the fish to applicants en route to Erwin. In order that the car might be available at an early date for distributing the large surplus of trout that was being carried at the White Sulphur Springs (W. Va.) station, thus relieving the congested conditions at that hatchery, the Erwin distribution work was rushed and the car moved the entire station output of 397,000 brook and rainbow trout and 17,000 miscellaneous pond fishes in three trips, supplying applicants in North Carolina, South Carolina, Georgia, and Tennessee. Between April 28 and June 5 the car distributed from the White Sulphur Springs station 880,400 fingerling brook, rainbow, and Loch Leven trout, making deliveries to 475 applicants in Virginia, West Virginia, and Pennsylvania. During the remainder of the fiscal year the services of this car were loaned to the Maryland Conservation Commission.

In the course of the year the car made 26 trips, traveled 23,497 miles, carried 1,778,806 trout and pond fishes, and supplied 1,581 individual applicants in 13 States. The total cost of its operations was $7,502. Its distributions are summarized in the following table:

Species	Fingerlings No. 1	Fingerlings No. 2	Fingerlings No. 3	Fingerlings No. 4	Adults
Catfish		8,700	17,800	1,700	
Rainbow trout		275,900	191,650		
Loch Leven trout		35,500	4,800		
Brook trout	67,000	1,003,400			
Crappie		8,200	39,745		
Largemouth black bass		8,000	16,485	32,188	674
Rock bass	3,000			400	
Sunfish	46,000	2,800		1,205	3,200
Yellow perch		1,875	8,560		24
Total	116,000	1,344,375	279,040	35,493	3,898

PACIFIC COD FISHERIES[1]

By JOHN N. COBB
Dean, College of Fisheries, University of Washington

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NATURAL HISTORY OF THE COD

Strange to relate, while the fishery for Pacific cod has been prosecuted since early in the sixties, scientists are not yet agreed as to the proper name for the species. According to Bean[2] "Most writers

[1] Appendix VII to the Report of the United States Commissioner of Fisheries for 1926. B. F. Doc. 1014. (This is a revision of B. F. Doc. 830. A map showing the location and extent of the cod banks and the location of shore stations in Bristol Bay and Central Alaska in 1914 may be consulted in Bureau of Fisheries Document No. 830 or in the 1915 volume of the Report of thte Bureau of Fisheries.)

[2] The Cod Fishery of Alaska, by Tarleton H. Bean. The Fisheries and Fishery Industries of the United States, Pt. II, sec. 5, Vol. I, pp. 198, 199.

have referred to it under the name of *Gadus macrocephalus*, which was bestowed by Tilesius upon the Kamchatkan cod, the figure of which suggests that it was based upon a deformed individual. Cope, in 1873, described the young of the common Alaska cod as a new species, *Gadus auratus*, from specimens collected by Prof. George Davidson, of the United States Coast Survey, at Unalaska. Steindachner, in the Proceedings (Sitzungsberichte) of the Vienna Academy, LXI, 1, 1870, adopts the name *G. macrocephalus* for a large cod taken in De Castries Bay (mouth of Amur River), Siberia. In this example the length of the head is contained exactly three times in the total length to the extreme end of the pointed caudal peduncle. The same proportion, however, may be found in any place where large numbers of *Gadus morrhua* are taken, and it can readily be proven to be only a matter of individual variation."

In the summer of 1880, the late Prof. Spencer F. Baird, then United States Commissioner of Fish and Fisheries, sent Dr. Tarleton H. Bean to Alaska for the purpose of investigating its fish and fisheries, and he made the first extended report on the Pacific cod that had been made up to that time.[3] As a result of his investigations, he considers the Atlantic and Pacific cod as of the same species. Jordan and Evermann [4] call it *G. macrocephalus*, and in justification of this state.

> In external respects we recognize no distinction between this species [referring to a specimen 20 inches long taken in the Strait of Juan de Fuca by the *Albatross*] and the common eastern codfish, except that the head seems larger.

They also quote Doctor Gilbert [5] as follows:

> It has been frequently pointed out, and is well known to fishermen, that the Pacific codfish has a smaller air bladder or sound than the Atlantic cod. Pending an examination of this question, which we are not now in a position to make, we propose to recognize the Pacific cod as a distinct species.

Much has been said and written of the difference in size between the sound of the Atlantic cod and that of the Pacific. A large part of this is hearsay, based largely on the statements of fishermen, few of whom have ever made any effort to save them. I cut out a few sounds in 1913, but unfortunately these were lost in some way during transportation; and although it had been some years since I had cut a sound from an Atlantic cod, it seemed to me that the Pacific sounds were almost, if not quite, as large, but thinner. Some few years ago the Alaska Codfish Co. made an effort to save the sounds at one of its Alaska stations, but the men refused to do so except at an exorbitant price. A. Greenebaum, the president of the company, writes that the sounds are small in size.

The only authentic record I have of a direct comparison of Pacific and Atlantic sounds is in a letter from Dr. W. C. Kendall, ichthyologist, United States Bureau of Fisheries, under date of January 22, 1915, in which he states:

> The air bladder of the big Pacific cod [the weight of this was about 30 pounds and its total length about 39 inches], after removal, measured about 13 inches in length, with no perceptible horns excepting slight projections, but it had a very large pouch on each side of the anterior end.

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[3] The Cod Fishery of Alaska, by Tarleton H. Bean. The Fisheries and Fishery Industries of the United States, Pt. II, sec. 5, Vol. I, pp. 198–226.

[4] The Fishes of North and Middle America, by D. S. Jordan and B. W. Evermann. Bulletin, United States National Museum, No. 47, Pt. III, pp. 2541, 2542. (1898.)

[5] Ibid., p. 2542.

The air bladder of the big Atlantic cod [of a weight of 34¼ pounds and a length of 43½ inches] was of the same length approximately, pouches small, but the horns, which could not be fully straightened out, measured each 10 inches in length. In natural position in the fish they are coiled up.

The small Pacific cod [8 or (9?) pounds and 28⅜ inches long] was in such bad condition that the air bladder could not be removed intact, but the one horn that could be found was only 1 inch in length.

FIG. 1.—Alaska cod on the deck of the *Albatross*

The other Atlantic cod [weights and lengths about the same] had air bladders and horns, as follows: Length 9¼, horns 2½ and 3; length 10½, horns 3¼ and 3¼; length 10 inches, horns 7 and 5½ inches.

It is to be hoped that some one will soon take up the study of the comparison of the sounds from the cod of both oceans, as should the Pacific sound prove to be uniformly smaller than those from the Atlantic cod, it would furnish a distinguishing feature.

DISTRIBUTION

The Pacific cod occasionally is found as far south as Cape Flattery on the Washington coast. From Puget Sound north to southeast Alaska they are said to be more common, although in no part of this region is a commercial fishery maintained for them. A few are taken by the halibut fishermen and marketed under the name of "gray cod." In southeast Alaska, in early years, a small fishery was maintained in and adjacent to Chatham Strait, but nothing has been done here of recent years. Cod in abundance are not to be found until the Portlock Bank is reached. From here to Akutan Pass cod are very abundant, and probably will be found in considerable abundance along the Aleutian Chain beyond the pass. In Bering Sea, between Unimak Pass and Bristol Bay, are to be found several large and important banks adjacent to Unimak Island and the Peninsula. They have been reported as far north as St. Lawrence Island in Bering Sea, but none have been reported in the Arctic Ocean. Edgar O. Campbell,[6] a school-teacher for the United States Bureau of Education, on St. Lawrence Island, in a letter dated September 21, 1909, has the following to say as to the presence of cod around the island:

A few codfish feed here and are caught every year from July to October, but not in any appreciable numbers except every third to fifth year. This year promises to be a good one, although the Eskimos are so timid they will not go out for more than a half mile from shore in their skin canoes. Some years the fish stay until in November and great numbers of them are caught by the ice as the sea freezes over. How do you suppose this happens? I have supposed that, as the top of the sea coats over with a slushy soft ice, the cod, for some reason or other, it may be for air, jump up through the ice and fall on the surface, their weight not being sufficient to carry them below into water again. At any rate they soon freeze and, as soon as the ice is solid enough to walk on, the Eskimo bring them home in great piles, like cordwood. This has happened twice since we came in 1901. In such years the fox catch is sure to be light, for the fox are so well fed they are wary of prepared bait.

On the Asiatic shore cod have been reported as far north as Cape Chaplin, East Siberia, while they have been found as far south as Hakodate in Japan. They are most abundant in the Okhotsk Sea.

SIZE

A very erroneous idea of the size of Pacific cod seems to be prevalent in certain works on ichthyology. Even as late as 1907 Evermann and Goldsborough[7] state: "We have no record of any large examples of this cod from the Pacific, where it perhaps does not reach a weight exceeding 15 or 20 pounds." Bean[8] reports having seen many that weighed not less than 30 pounds caught on the inshore banks, where the cod are notably smaller than those found on the offshore banks. He also quotes reports from others as to cod weighing from 20 to 50 pounds.

I spent the summer of 1913 at the Pirate Cove station of the Union Fish Co. During the greater part of the time no snappers

[6] Mr. Campbell had written for information as to how the natives could best catch cod for their own use.

[7] The Fishes of Alaska, by B. W. Evermann and E. L. Goldsborough. Bulletin, U. S. Bureau of Fisheries, Vol. XXVI, 1906, p. 348. (1907.)

[8] The Cod Fishery of Alaska, by Tarleton H. Bean. The Fisheries and Fishery Industries of the United States, Pt. II, sec. 5, Vol. I, pp. 202, 203.

were to be seen and the fish averaged very large—probably 12 to 15 pounds most of the time. On June 15 I weighed six cod, selected so as to show the different sizes, with the following results: One weighed 40 pounds, length 43 inches from tip to tip; 1 weighed 37 pounds, length 42½ inches from tip to tip; 1 weighed 22 pounds; 1 weighed 21 pounds, length 39 inches from tip to tip; 1 weighed 23½ pounds; 1 weighed 11½ pounds, length 31 inches from tip to tip.

I had the first fish dressed immediately after being weighed and measured, and when ready for the salting tank it weighed 21 pounds. Before being weighed in the first place all of these fish had been bled by having their throats cut.

On a number of occasions I saw fish at the shore stations that undoubtedly would run over 40 pounds if put on the scales. All of the fish noted above were from inshore banks. Cod run larger in size on the offshore banks, and it is probable that fish running from 50 to 60 pounds are taken sometimes on Slime and Sannak Banks, where the largest cod are found.

During the winter months the cod are very thin and watery, and probably would not average in the round much more than 7 to 9 pounds.

There are no records of any monster specimens having been secured on the Pacific banks, similar to those reported occasionally from the Atlantic. Capt. J. A. Matheson, of Anacortes, Wash., who has been engaged in the cod fishery for a number of years, says that the largest dry-salted cod he ever received from his vessels weighed 18 pounds.

In the southern part of its range the cod are generally small, in many places being no larger than those known as snappers on the cod banks.

MIGRATIONS

On the main cod banks fish are to be found throughout the year, although they are very scare at times. On certain of the inshore banks cod are to be found all the year in considerable abundance, with periods of great abundance; on other inshore banks only during the winter months are the fish found in any abundance, while on others they are plentiful only during the summer months. Pirate Cove, Unga, and Kelleys Rock are all-the-year-round stations, the Sannak Island and Northwest Harbor stations are all-winter ones, while Sanborn and Dora Harbors are open only during the summer months. At the stations open the whole year the best fishing is usually from March to September, both inclusive. Part of this superiority undoubtedly is due to the better weather that prevails during these months than during the rest of the year, but the reports and statistics all agree in showing that there is a greater shoreward migration of the schools during this period.

SPAWNING

Cod are found spawning during the winter months, principally in January and February. Those caught during February and March and the early part of April usually are very thin, in consequence of their having spawned shortly before this.

In many females the eggs are not extruded at the regular period, and in many instances these eventually harden into an almost solid mass. At Pirate Cove, in 1913, my attention was early called to these delayed spawners. The first one was observed on May 10, shortly after my arrival at the station. From then on they occasionally appeared until early in August, when they became quite numerous. On June 25 I cut out of one female a roe that weighed 8 pounds. Occasionally the eggs were found in a mass with the usual envelope missing. In no instance that I observed did this condition seem to affect the health of the fish, all of them appearing to be normal fish so far as food qualities, weight, etc., were concerned.

YOUNG

Doctor Bean's observations showed young cod as present in shallow water near shore at some place or other on the Pacific side between Cooks Inlet and Unalaska between May and October, and that about the middle of the latter month they reach an average length of 4 or 5 inches.

On September 7, 1913, I first noticed large numbers of young cod from 2 to 4 inches in length swimming around Pirate Cove harbor, and they were still there in large numbers when I left on September 26. The small native boys would catch them occasionally on a baited hook or bent pin, which the fry would pursue eagerly. They were found occasionally also in the stomachs of adults brought in by the fishermen, showing conclusively that the cod do not discriminate against their own offspring.

FOOD

The food of the Pacific cod is as plentiful and as varied as in the Atlantic. Any fish that it can capture forms a part of its food. I opened and examined the stomachs of many cod at Pirate Cove station during the summers of 1912 and 1913, and was surprised at the variety of food found therein. During July, 1913, shrimp were exceedingly abundant in their stomachs. I also found three ducks with bright red feet, known locally as "Alaska pigeons." These evidently had been swallowed but a short time before, as they were all in an excellent state of preservation. Alaska pollock (*Theragra chalcogramma*) seemed to be the chief food of the cod, although, strange to relate, it was found to be absolutely worthless as bait when cut into pieces. Sculpins are frequently found in its stomach, as are also salmon, herring (*Clupea pallasi*), capelin, halibut, and sand launce (*Ammodytes personatus*). Yellow striped fish, or "Atka mackerel" (*Pleurogrammus monopterygius*), is a popular article of food. Sometimes young cod are found in the stomachs of the adults. Octopi and shrimp are favorites of the cod, and during the summer months their stomachs will be found, in certain sections, to be filled with the latter.

OTHER MEMBERS OF THE GADIDÆ

An odd feature of the cod fisheries of the Pacific is the total absence of the haddock and hake, which form such a large proportion of the catch of the Atlantic Gadidæ fishery. The pollock of Alaska

is quite different from the one found on the Alantic. The minor species of the Gadidæ found on this coast are described below.

Ling.—The ling (*Lota maculosa*) is our only fresh-water member of the Gadidæ, and is said to be common in the Yukon Basin, and has also been reported from the Nushagak, Fraser, and Columbia Rivers. Large numbers are found in Lake Chelan, Wash. It attains a length of 1 to 3 feet. Although fully as palatable as the ling found in east-coast streams, it is rarely utilized as food, except in British Columbia and Washington, where small quantities are marketed.

Tomcod.—The tomcod, or wachna (*Microgadus proximus*), is found in abundance from Alaska to Monterey. In the more southern portions of its range it is often sold in the markets as "smelt." In form the tomcod is a miniature cod, and there is difficulty in distinguishing the young of the two species. The tomcod rarely exceeds a foot in length and is esteemed as a delicacy in many localities.

In the northern portion of Bering Sea the wachna, as it is called, is of great importance to the natives, who depend upon it for a considerable part of their food supply during the winter season. Mr. Dall [9] has the following to say of this fishery:

> This fish much resembles the common tomcod of the Eastern States, * * * but while the latter is of most insignificant importance from its scarcity and poor quality, the former species occupies a very important place in the domestic economy of both natives and Russians on both shores of Bering Sea. It is apparently a permanent inhabitant of these coasts, but is most abundant in the fall of the year, when the ice begins to form in the rivers and along the shores. The Waukhni fishery commences about the middle of October. At first it is caught from boats anchored close inshore, but later the natives cut holes in the new ice, set up two or three stakes, with a mat hung upon them to keep off the wind, and sit there all day, hauling them in as fast as the line is dropped into the water. The hook is made of white walrus ivory, furnished with a sharp pin set in obliquely but without a barb. The whiteness of the ivory, which is kept constantly in motion, attracts the fish, but no bait whatever is used. In November, when the ice becomes very thick and the cold increases, the fish retire to deeper water, and the fishing is over until the following spring. * * * They are preserved by removing the intestines and drying in large bunches strung on seal line, or by throwing them as they are into long cylindrical baskets made of twisted grass and keeping them entire in a frozen state. * * * They are among the most palatable of the many fish found in these seas, and the number preserved is so great as to be almost incalculable. They serve the natives for food, either boiled or in the frozen state. They also form an important article of dog feed in the northern portions of Alaska near the coast.

Hon. James Wickersham, former Delegate from Alaska, furnished me the following description of the apparatus used by the natives and their method of operating same:

> When the Eskimo woman is fishing through the ice on Bering Sea for tomcod she uses a line with a barbless hook at the end. She also has two short sticks in her hands and generally a baby strapped on her back. As soon as she gets a bite she slips one stick a foot or two down the line and begins raising it up. As soon as the stick gets too high she slips the other a few feet below the first but on the other side of the line, and thus continues hauling in the line with the sticks alternately until finally the catch comes above the ice. With a quick movement of the line and stick the fish is shook off, and frequently before it falls onto the ice is frozen solid. The woman is wearing heavy gloves, and the reason for not touching the wet line with the gloved hands is to prevent them from getting wet and covered with ice and thus becoming useless. The line is

[9] Report of Commissioner of Agriculture for 1870, p. 381. (1871.)

lowered in the same manner, and from long practice the natives are very expert. The fish are put in baskets and will keep fresh as long as they remain frozen. A windbreak of ice and snow is frequently constructed.

Alaska pollock.—The Alaska pollock (*Theragra chalcogramma*) is an abundant and widely distributed species in Alaska. It is found in the Bering Sea and the neighboring waters south to Sitka and the Kurils. It usually swims near the surface and forms a considerable portion of the food of the fur seal and the cod. It reaches a length of 3 feet, although the average is more nearly about half this. At present no use is made of it as food, although in time it will become an important item in the commercial fisheries. In 1907 the writer caught a specimen at Seward, Alaska, but it was apparently so rare in that locality that no one there seemed to recognize it.

South of Sitka is found a closely related species, *T. fucensis*, which is said to be abundant in Puget Sound and is found as far south as Monterey Bay.

Eleginus navaga is common and abundant along the entire Alaska coast and on the Asiatic side as far south as the Kamchatka Peninsula at least. It is rarely used as food because of the great abundance of other better-known fishes.

Polar cod.—The polar cod (*Boreogadus saida*) is common along the coasts of Arctic Alaska and northern Siberia. Like the pollock, this species has the lower jaw longer than the upper. They form an important article of food with the Eskimos during certain seasons of the year. John Murdoch [10] has the following description of the fishery:

> Usually during the latter part of October and early in November, after the sea has closed and when tide cracks form along the shore, the natives generally catch a good many of them at the very edge of the beach in about a foot of water.
>
> They use a short line of whalebone, to which is attached a small lure made of blackened ivory, which roughly represents an amphipod crustacean and is armed with a barbless hook.
>
> After this no more are caught till after the return of the sun, early in February. The natives say that they go away, and it is quite probable that they leave the shore and go off into deeper water. If there were any fish to be caught, the natives would undoubtedly fish for them during the winter months, as at this season they are frequently hard pressed for food.
>
> Early in February they become exceedingly abundant in about 15 fathoms of water wherever there is a level field of the season's ice not over 4 feet in thickness, inclosed between rows of hummocks of broken ice. * * * Large numbers of the natives from the Cape Smythe Village, especially women and children, resorted to this field nearly every day and caught these fish literally by the bushel.
>
> The fish are jigged and the hook is kept near the bottom.

SPECIES MISCALLED COD

A confusing feature on the Pacific coast is the number of species, unrelated to the Gadidæ and none of which resemble the true cod, which are commonly known as cod and which frequently are classed with the cod by the uninitiated. Among these the more prominent are the following:

Cultus cod, blue cod, buffalo cod, or ling cod (*Ophiodon elongatus*) is a large, coarse fish that reaches a length of 3 to 4 feet and a weight

[10] Natural History, Report of the International Polar Expedition to Point Barrow, Alaska, Fishes, pp. 129–130. (1885.)

of 30 or 40 pounds, with the flesh a livid blue or green in color. In cooking, the flesh of this fish turns white. It is found from Sitka to Santa Barbara, and is especially important as a food fish in British Columbia and the State of Washington.

Sablefish, black cod, coalfish, beshow, or skill (*Anoplopoma fimbria*) is found from the Aleutian Islands to Monterey. It is most abundant in the regions frequented by halibut, from southeast Alaska to the Washington coast. It attains a length of 18 to 20 inches and a weight of 5 pounds. Many are marketed in a fresh, frozen, or salted condition, and the fish is growing steadily in popularity. Usually it is taken in deep water, from 70 to 90 fathoms, though often it is found at depths of 200 to 250 fathoms. About 1916 I recommended that the name "sablefish" be used for this fish, and it has been so called since then.

Several species of Sebastodes (notably *S. ruberrimus*, *S. pinniger*, and *S. mystinus*), known as red rock cod, are found from San Diego to Alaska. They are excellent food fishes and are in considerable demand.

BANKS FREQUENTED BY COD

The codfishing banks are of two kinds—the inshore banks, which lie close in to shore, or in the bays, straits, and sounds between the numerous islands and the mainland and between the islands themselves; and the outer banks, which lie at varying distances off the mainland or the various groups of islands. Together they form by far the largest group of cod banks in the world.

Outside of the surveys made by the United States Bureau of Fisheries' steamer *Albatross*, very little has been done to fix with certainty the boundaries of the various banks and much remains to be accomplished in this line. The *Albatross* survey has been supplemented by data obtained from fishermen that frequent these banks and from personal observation over a period comprising several fishing seasons.

According to the investigations of the *Albatross*, the following represent, roughly, the areas of the offshore banks upon which she worked, although in several instances the work was suspended before the end of the bank was reached:

	Sq. miles
Slime Bank	1,445
Baird Bank	9,200
Between Ugomak Island and Kiliuluk Bay, in the Pacific Ocean	2,000
Davidson Bank	1,600
Sannak Bank	1,300
Between Sannak and Shumagin Banks	1,800
Shumagin Bank	1,800
Albatross Bank	3,700
Portlock Bank	6,800
Total	29,645

No attempt was made by the *Albatross* to seek for cod banks along the Aleutian Chain west of Akutan Pass, where cod are said to be numerous. Also no attempt was made to find banks in Bering Sea north of Cape Newenham, although cod have been found as far north as St. Lawrence Island.

No estimate ever has been made of the extent of the inshore banks, which are very extensive. It is probable that these would be from one-third to one-half the area of the offshore banks, possibly more.

No one knows the extent of the cod banks along the Asiatic shores of the Pacific Ocean, but they can not be much smaller, if any, than those on the American side, and it is possible that more extended investigations will develop that they meet the American banks at certain places.

OFFSHORE BANKS IN BERING SEA

Owing to a lack of good harbors in Bering Sea, the offshore banks are the only ones frequented at present by the fishing vessels, and these are among the most productive in all Alaska. As the holding ground on these banks is good, a properly equipped vessel finds little difficulty in riding out all ordinary gales. All cod banks so far found are situated mostly to the eastward of a line connecting Cape Newenham with the northwest cape of Unimak Island and off the northern side of Unalaska Island.

Slime Bank.—The first cod bank to be reached by a fishing vessel after entering Bering Sea is Slime Bank. As delineated by the *Albatross*, it begins directly off Cape Sarichef, the northwest cape of Unimak Island, is elongate in shape, and follows approximately the trend of the adjacent coast to within a few miles of Amak Island, its inner margin lying only a short distance off the land. It is about 85 miles in length and 17 miles in average width, broadening somewhat at the eastern end; its total area is estimated at about 1,445 square miles. The depths found on the bank range from 20 to 50 fathoms, while the bottom consists generally of black sand and gravel, frequently intermingled with pebbles, and sometimes of gray and yellow sand, rocks also occurring near the shore.

The deep water lying off the northern entrance to Unimak Pass forms the western end of the bank, 70 fathoms being found near the edge and depths exceeding 100 fathoms a short distance farther away. Off its northern edge the depths determined by the soundings of the *Albatross* range from 53 to 62 fathoms, with muddy bottom at three of them. Toward the eastern end, however, on the northern side sand and gravel occur, and in this locality the precise limits of the bank are still undefined.

There are no harbors suitable for cod vessels along the adjacent shore, although protection may be found in several bays, notably Dublin and Shaw Bays, during southeast to southwest winds. Amak Island, which lies about 11 miles off Izenbeck Bay, also furnishes some protection during the prevalence of southeast and southwest winds.

The bank derives its name from the presence of immense numbers of a large jellyfish, brownish or rusty in color, measuring 6 to 18 inches across the disk and provided with long slender tentacles having great stinging powers. It is said by the fishermen that the jellyfish never are observed upon the surface of the sea, but seem to occupy an intermediate zone toward the bottom. They claim that these animals sometimes interfere with the hooks that reach bottom and by covering the bait render it unattractive to the fish. When brought to the surface they are uncomfortable objects for the fisher-

men to disentangle from the hook and line. They do not become abundant until the latter part of June, when the fishermen generally move on to Baird Bank.

Probably the finest cod secured on any of the Alaska banks are taken on Slime Bank.

Baird Bank.—Baird Bank, so named by Captain Tanner of the *Albatross* in honor of Prof. Spencer F. Baird, the first United States Commissioner of Fish and Fisheries, was then generally known to the fishermen, and is yet to a few of them, as the Port Moller bank or ground. As described and charted by the *Albatross*, it commences a few miles east of Amak Island and extends northeastward off the northern side of the Alaska Peninsula to the vicinity of Cape Chichagof, at the mouth of the Ugaguk River, a distance of about 230 miles. It has an average width of about 40 miles and an extreme width of 58 miles, its total area being estimated at about 9,200 square miles, making it the largest known bank in Alaska, and some 800 square miles larger than Georges Bank in the North Atlantic Ocean.

The *Albatross* investigations, however, indicated a strong probability that the Kululak ground and the region off Cape Pierce are really extensions of this bank, the investigations not having been carried to a definite conclusion with respect to this matter. Outside of Bristol Bay the observations were not carried beyond the limits of the bank as defined by the *Albatross*, and the entire width of its western portion still remains to be determined. It is also not impossible, according to Captain Tanner, that some connection may be found to exist between Baird and Slime Banks to the north of Amak Island. A line of stations from Cape Newenham to the Northwest Cape of Unimak Island, however, showed good fishing only in the vicinity of land.

Like Slime Bank, but few harbors are to be found along the shores adjacent to Baird Bank. Vessels occasionally take refuge in Port Moller, Herendeen Bay, and Port Heiden, but usually the vessels ride out the storms or draw in close to the peninsula shore during southeast winds.

Kululak Bay.—Kululak Bay occupies a large part of the region included between Cape Constantine and Cape Newenham and contains Hagemeister Island and the Walrus Group. Within this area the *Albatross* investigators found cod in isolated spots, scarcely entitled to the name of banks. Extensive shoals occur off Hagemeister and the Walrus Islands, 6 fathoms being found about 15 miles to the southward of the latter. The principal fishing grounds are outside of these shoals as well as to the eastward and westward of them, in depths of 12 to 25 fathoms, the bottom consisting generally of sand, with some mud and gravel, and the fauna being essentially the same as on Baird and Slime Banks.

Some years ago the fishermen occasionally resorted to a small ground, called Gravel Bank, situated about 16 miles south-southwest from the southern end of Hagemeister Island, where large cod were reported to be abundant. It has depths of 16 to 20 fathoms, but its size is inconsiderable.

Vessels entering Bering Sea fish first on Slime Bank, usually in or just off Dublin Bay. From here they work to the eastward, leaving

for Baird Bank when the jellyfish become too numerous on Slime Bank. No fishing is now conducted on the Kululak ground.

The *Albatross* investigations were not carried north of Cape Newenham; cod have been reported at various places between here and Bering Strait and in the Arctic. They are said to be abundant in the neighborhood of St. Lawrence Island.

OFFSHORE BANKS IN THE NORTH PACIFIC OCEAN

The *Albatross* ran three lines of soundings over the area lying between the longitude of Ugamok Island, at the southern entrance to Unimak Pass, and that of Kiliuluk Bay (longitude 164° 55′ to 167° west) and between the coast and the inner edge of the steep submarine slope. These soundings were not sufficient to demonstrate the existence of a defined bank in this region, but it was estimated that an area of about 2,000 square geographical miles was suitable for

FIG. 2.—Schooner *Maid of Orleans* at anchor on Sannak Bank in the North Pacific Ocean

fishing. This has been borne out by the experiences of a number of fishing vessels that have made good catches at certain places in this area on various occasions.

Even farther to the westward occasional trials have been made by cod vessels, when becalmed inside the 100-fathom curve or when seeking water, and good catches of cod made.

Davidson Bank.—This bank was first reported by Prof. George Davidson, of the United States Coast Survey, about 1868, and was named in his honor. He made a number of soundings upon it in depths of about 50 fathoms and found cod abundant in some places. In 1888 the *Albatross* established the outline and surface contour of this bank with considerable accuracy.

The bank lies south of Unimak Island and extends westward from the neighborhood of the Sannak Islands to about the longitude of the southern entrance to Unimak Pass (about longitude 164° 40′

west). Its eastern end seems to be continuous with the shoal water surrounding the Sannak Islands. The greatest width of this bank off Unimak Island is 45 to 50 miles. Depths less than 50 fathoms were found over a large part of the bank, 41 fathoms being the shoalest water discovered. Between the shallow area and the islands to the north and northwest of it depths of 50 to 72 fathoms occur. The area of Davidson Bank is estimated at about 1,600 square miles.

The bottom upon the bank consists, in different places, of fine to coarse sand, pebbles, and gravel. Green mud is found at a depth of 95 fathoms near the outer edge of the bank and black sand in 342 fathoms just off the bank.

Sannak Bank.—The principal bank resorted to by the few vessels that fish throughout the season in the North Pacific is Sannak Bank. This bank lies to the east and southeast of the Sannak Islands, is somewhat elongate in shape, and trends in a general way northeast and southwest. About the central spot on the bank is in latitude 54° 20′ north, longitude 161° 53′ west. To the westward it joins Davidson Bank, the dividing line being at a point approximately south of the middle of the group. The soundings on this bank show depths from 30 to 82 fathoms. Much of the bottom is rocky; sand, pebbles, and gravel also occur. The estimated area of the bank is 1,300 square miles.

The cod taken on this bank are very large and of excellent quality, and are the finest fish taken on any of the Alaska banks, with the exception of those from Slime Bank in Bering Sea.

For the mariner unacquainted with these waters, this is a dangerous region, but for one acquainted harbors of refuge are numerous. Caton Harbor, formed by Caton, Elma, and Sannak Islands, is the chief place of refuge for the larger vessels, as it is easy to get into from either the northern or southwestern entrance, and inside there is excellent holding ground and ample protection from all winds. Small vessels, especially power vessels, in case of storm generally anchor close in to the leeward of Caton Island and are safe. On the northern side of Sannak Island vessels drawing 14 and 15 feet can enter Pavlof Harbor easily at high tide, but at low tide vessels drawing more than 6 feet would have difficulty in entering. The channel is rather tortuous but is buoyed. Inside the anchorage is limited, as the harbor is small. The Union Fish Co. has a large station here, and vessels can lie alongside the dock at all stages of the tide, large ones usually resting easily in the mud at low tide. Johnsons Harbor, where there is another station of the same company, can be entered at any stage of the tide, the entrance being unusually free from obstructions, but the harbor is so shoal throughout the greater portion that the vessel anchorage is restricted largely to the western part, a little inside the entrance. Farther to the westward are Moffets Cove and Company Harbor, on both of which are shore stations of the Alaska Codfish Co., and which are accessible to all cod-fishing vessels at high tide.

When fishing on this bank, the larger vessels generally ride out storms. When the vessel begins to drag, the anchor usually is buoyed and the vessel either puts to sea or goes to Caton Harbor.

Between Sannak Bank and the beginning of the Shumagin Bank, to the eastward, lies a large area of comparatively shoal water, over

the greater part of which cod are to be found in varying abundance, although this ground is not much frequented, owing to the absence of convenient safe harbors in its western half and the presence of the dangerous Sandman Reefs to the northwest. In the eastern portion vessels can easily find shelter among the Shumagin Islands. Occasionally a few vessels fish in this region for a short portion of the season. This area shows depths of 38 to 74 fathoms and is, roughly, about 1,800 square miles in extent. The bottom is exceedingly variable, consisting in various places of sand, mud, pebbles, gravel, and rocks, the latter occurring only near Sannak Bank on the one side and near the Shumagin Islands on the other.

Shumagin Bank.—Shumagin Bank lies to the south and southeast of the Shumagin Islands, with its outer margin following approximately the trend of the coast line formed by the adjacent islands.

FIG. 3.—Union Fish Co.'s Pavlof station, Sannak Island, Alaska

On the westward the bank has been traced to about longitude 159° 52′ west, but undoubtedly extends farther in this direction. East of the Shumagin Islands it reaches north to the latitude of the upper end of Big Koniuji Island. Its width within the 100-fathom curve to the south of the group varies from 15 to 35 miles to the nearest outlying island, while its area has been estimated at about 1,800 square miles. The depths over a large part of the bank are less than 50 fathoms, the bank not being separated from the islands by deep water. The character of the bottom on the bank varies greatly, sand, pebbles, gravel, broken shells, mud, and rocks being found in various places. Rocky patches are of frequent occurrence, even in comparatively deep water. These rocky patches are a grave source of danger to vessels anchored on the bank, as they chafe and break rope cables.

The schooner *Vega* fished on this bank, to the south of Simeonofski Island, in 1913 and 1914, and was compelled to use a couple of shots of chain next to the anchor in the latter year, having lost an anchor the previous year because a rope cable was employed. Owing to this danger and to the strong tides, few vessels ever have made a practice of fishing on this bank, although the fish rank in quality next to those caught on the Sannak and Slime Banks.

The area between the Shumagin Islands and Kodiak is very imperfectly known, largely because the fishing vessels do not frequent it, preferring to visit the better known banks. The *Albatross* (in 1888) ran a single series of soundings across this wide area, with a double line extending from the neighborhood of Lighthouse Rocks to Mitrofania Bay. These showed on the single line depths of 26 to 137 fathoms, while the double line showed depths of 44 to 73 fathoms.

Albatross Bank.—This bank lies off the southeastern side of Kodiak Island and extends the entire length of that island as well as in front of the Trinity Islands. At the eastern end it is almost continuous with Portlock Bank. Along some portions of the coast, as in the neighborhood of Sitkalidak Island, the bank is separated from the land by comparatively deep water, while in other places shoal water intervenes. The 100-fathom curve is distant 25 to 45 miles from the land, inside of which limit there is an estimated area of 3,700 square miles. Depths from 40 to 60 fathoms are most common on the bank. Beyond the 100-fathom line the slope is very abrupt. All varieties of bottoms occur, sand being most prevalent and rocky patches common.

Prof. George Davidson, one of the earliest investigators of the fishing banks off this portion of the Alaska coast, predicted the existence of this bank upon the evidence of a few isolated soundings. The bank was later named after the *Albatross*, which surveyed it.

In the early years of this industry this bank was frequented by small vessels with headquarters at Kodiak, but as most of the fish taken are smaller than on the other offshore banks, it has not been much resorted to except during the past seven or eight years.

Portlock Bank.—Portlock Bank extends northeastward from Kodiak Island to about longitude 148° 30′ west, a distance of 110 to 120 miles, and is widest at the western end. Its outline, as indicated by the 100-fathom curve, is irregular. It is the largest single bank south of the Alaska Pennisula, its area inside the 100-fathom curve being about 6,800 square miles. The boundaries of this bank have not been established conclusively as yet, and eventually it may turn out to be much larger than is supposed. No soundings were made by the *Albatross* nearer than 16 miles south of the Kenai Peninsula. Between longitudes 150° and 151° west the bank abruptly narrows, and thence maintains a width of 35 to 45 miles to its eastern end. There is a broad indentation, with depths of 102 to 166 fathoms, on the southern side; depths of 105 to 122 fathoms occur just off the northern border, and 106 to 761 fathoms off the eastern end, close to the 100-fathom curve.

The soundings made by the *Albatross* between longitude 150° west and the eastern end of the bank, inside of the 100-fathom line, show

depths of 66 to 99 fathoms. Near the central part of the bank, between longitudes 150° and 151° west, two soundings of 37 fathoms occur, while on the southern part depths of 40 to 72 fathoms were found. Between longitudes 151° and 152° west, the latter marking approximately the western boundary of the bank and the coast line, the depths, according to the soundings of the *Albatross*, range from 20 to 81 fathoms, the latter occurring near the land; but there were no indications of a marked or extensive depression between the bank and the shore.

Gray sand prevails over most of the bottom, mixed with pebbles, gravel, and broken shells in places, with occasional patches of mud and some rocky spots on the western part of the bank.

In 1888 the *Albatross* made a single series of soundings between the eastern end of Portlock Bank and Middleton Island, which showed depths of 87 and 101 fathoms about midway between the two, indicating a small area surrounded by much deeper water.

In 1911 the *Albatross* covered this same region more extensively in its search for halibut banks, but on neither occasion were cod found.

During the latter investigations the region between Middleton Island and Dixon Entrance was covered by the *Albatross*, but only an occasional cod was found, and the work of the halibut vessels over this area indicates that cod are quite scarce.

INSHORE BANKS

These banks generally are close to shore, usually around islands, and are those resorted to by the fishermen from shore stations adjacent (from whence the cured product is shipped to market) or by the natives and whites living close by, who catch enough for their immediate wants or cure a few for their food in winter. Observations at a number of places show that cod caught close to the mainland shores generally are smaller than those found on the offshore and the island inshore banks. Virtually no cod are taken for market on the inshore mainland banks.

It was noticed that sick cod generally sought the shelter of the harbors. At Pirate Cove, in the Shumagins, and at Pavlof, on Sannak Island, I frequently noticed medium-sized cod in the harbors, and almost invariably these were found to be sick or diseased. A few yards outside the harbors only clean, healthy fish were found, showing that their condition caused the diseased fish to seek the shelter of the harbor.

There are a few small banks in southeast Alaska. These banks, which vary from 5 to 7 fathoms in depth, are mainly in Chatham Straits, Lynn Canal, and Icy Straits. The fish are found on the banks in the summer, disappearing into the deeper water in the fall. The fish caught are comparatively small, examples more than 24 inches in length being rare. It is probable that if a search were made numerous other banks would be found.

Although cod are found occasionally near Sitka, Yakutat, in Prince William Sound, and Port Graham, near the lower end of the Kenai Peninsula, but few are taken by fishermen. At one time many cod were taken by the natives living on Kodiak, Afognak, and adjacent islands, but of late years the natives have given most of

their time to the salmon fishery. The fact that the cod found on these banks are very small has militated heavily against their sale in a dry-salted condition, in which trade only large fish are of much value. In 1909 the Alaska Commercial Co., at its Kodiak station, purchased from the native fishermen and dry-salted a considerable quantity of cod, but they were so small that they could be marketed in San Francisco only at a loss, with the result that the fishery was abandoned for the time being. During the last eight years the fishery has been renewed and is now quite important, the fishermen now resorting to the deeper waters, where larger fish are to be found.

In Chignik Bay cod are found frequently. At Mitrofania the natives cure considerable quantities for their own use, while in 1912 some stockfish was prepared by a number of the natives. In 1912 I investigated the ground off Ivanof Bay. Good, large cod are to be found here, but the vessels have never found it necessary to resort to this ground, while a shore station could not operate, as, should the wind from the ocean suddenly shift to the land, a dory would be blown straight out to sea. A vessel would find Kupreanof Harbor a very safe and convenient refuge.

On Herendeen Island, on Northwest Harbor, a small island to the northward of Little Koniuji Island, are located two shore stations, which are operated during the winter and spring months. During the summer months the cod are mostly on the offshore banks, too far away for the dories to take them. Several vessels have operated with marked success on this offshore bank, which is really a prolongation of Shumagin Bank, but as the bottom is rocky, anchors frequently are lost.

In the Shumagin and Sannak groups, shore stations to operate on the inshore banks have reached their greatest development.

In the Shumagins these banks are very numerous, spots where cod can not be taken at some time during the year being exceedingly rare. The best known banks are in West Nagai Strait and Gorman Strait. The majority of the Shumagin Island stations are on the former sheet of water, it forming virtually one continuous bank. On the western side fishing is carried on throughout the year, while on the eastern side fishing generally is begun in May and ended in August, June and July being the best months. The stations on the western side find the cod most abundant from March to October, the former month being the best. It is probable that they are just as abundant during the rest of the year, but the weather generally prevents much fishing. A considerable part of this bank, lying in the middle of the strait, has been fished but little, as the dories can not work that far from shore. During the last few years, however, the number of power fishing boats has been increased considerably, and as these can go much farther from shore than the dories, which are propelled by oars or sails, the middle ground is being worked more thoroughly. Occasionally the smaller vessels, with headquarters at the stations, have frequented the outer banks in West Nagai Strait. Around the Haystacks is an especially good fishing ground for a power fishing vessel. This ground extends from the pinnacle off East Head and the eastern point of Porpoise Harbor north to the southeast end of Andronica Island, and is said to extend

toward Wedge Cape, also, at the upper end of Nagai Island. The bottom on this ground is smooth and is composed of fine, hard gravel; the depth of water is about 30 fathoms. The strong tide and the proximity of the numerous small islets that form part of the group make the use of a power vessel necessary.

Should the otter trawl ever be adopted for codfishing, West Nagai Strait would be one of the most favorable spots in all Alaska for its operation, as it has a comparatively smooth sandy bottom with depths throughout the greater portion from 25 to 40 fathoms.

Pirate Cove, the oldest shore-fishing station operated in Alaska, is located on the northeast point of Popof Island. The grounds frequented by the fishermen of this place lie in Gorman Strait, between Popof and Korovin Islands, and along the eastern side of the island as far south as Popof Head.

In Unga Strait, an inshore bank begins at Gull Island, in 40 fathoms, and runs westward to Bay Point (known locally as Niggerhead). The bank is about a mile offshore and is about a mile in width, with a depth of about 30 fathoms nearly everywhere. The bottom is of packed sand, with very little moss.

In Portage Bay (now known as Balboa Bay) is a small bank, upon which large fish may be taken during the summer months. The bank extends up the middle of the bay to the 5-fathom sounding. The soundings on the bank range from 25 to 35 fathoms. The bottom is of gravel and contains numerous holes.

In Beaver Bay, along the peninsula, good fishing may be had. Here the bottom is sandy and the average depth is about 25 fathoms.

On the northern, eastern, and western shores of the Sannak Islands are inshore banks, on which cod are to be found throughout the late fall and winter; but throughout the rest of the year the fish are in water too deep for the station fishermen to fish. On the northern side are four shore stations. Owing to the danger of the fishermen being blown to sea in the gales that spring up very suddenly in this region, no shore stations have been established on the south side.

Along the shore of Unimak Island, from Cape Pankof to Cape Lutke, codfish used to be numerous during the summer months. This ground is really the inshore portion of Davidson Bank. At Dora Harbor, on the south side of Ikatan Peninsula, Unimak Island, are located two shore stations, and the fishermen from these fish out around Bird Island. For a year or two after the stations were opened they made big catches, but after that they dwindled until about 50,000 fish now represent the combined catches. Several schooners usually fish on the main ground, a few miles offshore during the spring months, off Cape Pankof being a favorite spot.

Just off Akutan Harbor, on Akutan Bay, cod are said to be abundant. While the schooner *Vega*, of Seattle, was taking aboard water in the harbor late in June, 1911, her fishermen, hand-lining from dories around the mouth of the harbor, caught 1,500 cod on one day and 2,700 the day following. The *Albatross* investigations in the same year showed that cod were abundant and quite large close inshore off North Head, Akutan Island.

The *Albatross* investigations showed that cod were abundant directly off Chernoffsky Bay, on the Bering Sea side of Unalaska

Island, during the summer, and it is probable that investigation will some day disclose many other inshore banks at various places along the Aleutian Islands where cod can be caught at all or at some seasons of the year.

But little is known of the inshore banks on the north side of the Alaska Peninsula, mainly because, owing to the lack of safe and convenient harbors adjacent to the banks, shore stations can not be operated.

BANKS ON THE ASIATIC SHORE

But little is known of the extent of the cod banks along the Siberian coast, as no detailed or even sectional surveys of them have been made. Our own vessels have done more toward showing their extent and productiveness than those of any other nation, except possibly Japan. The principal banks lie in the Okhotsk Sea and the Asiatic side of Bering Sea. How far north the fish range is still undetermined, but it is probable that they will be found about as far north on the Asiatic shore of Bering Sea as they are on the American shore; that is, to St. Lawrence Island. They are said to be found as far south as Chosen (Korea) and northern Japan.

HISTORY OF THE PACIFIC COD FISHERY

The history of the Pacific cod fishery is a record of the strenuous struggle of a few individuals and companies against its giant brother on the Atlantic coast, which, backed by great wealth, the prestige and advantage gained by years of unopposed command of the American markets, an almost unlimited supply of raw product, and at times the ability to import from the eastern Provinces of Canada large supplies free of all duty, has had an immense advantage over its younger and weaker brother. On this coast it has not been a question of being able to secure cargoes, but has been one of finding a market for the catch; a vastly greater catch could be made were a market available for it.

The fact of the presence of cod in Alaskan waters has long been known. In the speech of Hon. Charles Sumner [11] on the cession of Russian America to the United States, and which had such a powerful effect in favor of the treaty of cession then pending, is an abstract of the references made by early navigators and visitors in Alaska to its fishes. The first mention was made by a Russian navigator in 1765, who reported "cod, perch, pilchards, smelts," as being found around the Fox Islands. Other navigators and explorers who reported the presence of cod were Cook (1786), Portlock (1787), Meares, Billings (1792), Langsdorf (1804), Sutke, and Sir George Simpson (1841), all of whom speak of it as being a very common fish. But little use was made of it, however, owing to the abundance of salmon.

It is reported that in 1866 two or three small schooners fitted out at Victoria, British Columbia, and fished with fair success on the grounds immediately north of the Nass River. It is a question whether this fish was the true cod or one of the several unrelated species which bear the common name of cod.

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[11] Speech of Hon. Charles Sumner, of Massachusetts, on the cession of Russian America to the United States, 48 pp. Washington, 1867.

Capt. Matthew Turner seems to have been the pioneer in the discovery of the commercial possibilities of the great cod banks of the Pacific Ocean. W. A. Wilcox, late field agent of the now United States Bureau of Fisheries, received from the late Captain Turner the following facts in connection with his discovery of various banks and his exploitation of same:[12]

In 1857 Capt. Matthew Turner, master of the brig *Timandra*, 120 tons, sailed from San Francisco with an assorted cargo for Nicolaevsk on the Amur River. He was detained, however, for three weeks at Castor Bay, at the head of the Gulf of Tartary, because the Amur River was full of ice when he reached the Asiatic coast. While the vessel lay there waiting, anchored in 3 fathoms of water, the crew began fishing over the rail with hand lines simply as a pastime. They were surprised to find plenty of cod, averaging about 2 feet in length. Captain Turner had not previously seen codfish, but some of his crew were familiar with the species, and he, knowing their market value at San Francisco, appreciated the importance of the discovery and became interested in the fishing. Two years later Captain Turner made another trip to the Amur River. Reaching Sakhalin Island, off the Gulf of Tartary, he began fishing for cod and found them very abundant. Only enough were taken for ship's use, however, for he was not provided with the means to cure more.

In 1863 Captain Turner once more sailed in the *Timandra* to Amur River. But this time he went prepared to catch and cure some cod on his return voyage. Besides fishing gear he carried 25 tons of salt. Returning he stopped to fish at the Gulf of Tartary. Cod were plentiful at first, and 10 tons were taken in a few days and salted in kench. But suddenly the fish disappeared and none could be caught. Then the brig ran down the coast to southern Kamchatka, where fish were found in abundance, and excellent success was met with on the first day. The vessel lay near the rocky coast, and on the second day, during the prevalence of a dense fog, both anchors were lost. This mishap compelled Captain Turner to abandon fishing and to leave the coast; he reluctantly sailed for home. His fish sold at San Francisco for 15 cents per pound, and his voyage would have been notably profitable if the loss of anchors had not interefered with obtaining a full fare. This was the first occasion that salt cod were landed on the west coast from Pacific fishing grounds.

In 1864 Captain Turner sailed in his brig on a cod-fishing voyage. Thus the *Timandra* was the first vessel to engage in this industry from Pacific ports. On the same grounds visited the previous year a fare of 100 tons of codfish was obtained and the voyage was remunerative. The same year the schooner *Alert* made a trip to Bristol Bay, Alaska, in pursuit of cod. Her voyage proved a failure, for she took only 9 tons of fish.

Captain Turner states that since he made his voyages to the Gulf of Tartary, as related above, no American vessels have gone there to fish for cod. His success, however, had a very decided effect upon the cod-fishing business in the North Pacific, and in 1865 six vessels sailed from San Francisco to the Okhotsk Sea in pursuit of cod. These were the first American vessels to visit that region on cod-fishing trips, and their sailing evidenced a resolution to begin the business upon a broad commercial basis.

But Captain Turner, who seems to have possessed the spirit and enterprise of a pioneer or discoverer, determined to look for cod-fishing grounds nearer home. Not disheartened by the ill success of the *Alert* in 1863, he sailed for Alaska on the schooner *Porpoise*, of 45 tons, March 27, 1865, and arrived at the Shumagin Islands May 1. He began fishing the same day. Cod were abundant and close inshore. As a result, he returned to San Francisco on July 7 with a fare of 30 tons of fish—something less than a full cargo, which might easily have been secured, only for the desire to market the catch in advance of the arrival home of the vessels that had sailed to the fishing grounds on the Asiatic side of the Pacific. This was the first fare of cod from the Shumagin Islands, a locality since famous in the annals of the Pacific codfishery.

The cod-fishing fleet of 1864 was composed wholly of rather small-sized schooners, most of which were orginally built in New England for the Atlantic

[12] Report on the fisheries of the Pacific coast of the United States, by J. W. Collins. Report of United States Commissioner of Fish and Fisheries for 1888, pp. 92, 93. Washington, 1892.

fisheries, but had sailed around Cape Horn to find employment in the business of the Occident. It is remarkable that one of those that crossed the Pacific, sailing about 5,000 miles from home, was only 20 tons, a mere boat in which to make such a voyage, and to return loaded "nearly decks to the water." Following are the names and tonnage (in round numbers) of the fleet: *Equity*, 63 tons; *Flying Dart*, 84 tons; *H. L. Ruggles*, 75 tons; *J. D. Sanborn*, 71 tons; *Mary Cleveland*, 91 tons; *Porpoise*, 45 tons; and *Taccon*, 20 tons.

The Okhotsk Sea fleet all secured full fares and returned in safety. The fish were small, averaging only about 3 pounds each when dry. But in those early days they were in demand and sold for from 12½ to 15 cents per pound, a price that gave remunerative returns and the promise of future success for the fishery. There was no lack of cod, and even with the method of fishing with hand lines over the vessel's side then in vogue, no difficulty was experienced in filling moderate-sized schooners in a reasonable time.

The first vessel to visit Bering Sea for cod was the schooner *Alert*, from San Francisco, in 1864. But little is known of this vessel and her owner or owners, but it is recorded that the venture was a failure, as only 9 tons of cod were secured.

The regular Bering Sea fishery was inaugurated by the schooner *Tropic Bird*, owned by the McCollam Fishing & Trading Co., of San Francisco, in 1882. The schooner *Isabel* also visited the Bering Sea banks a few weeks later than the *Tropic Bird*. Both made good catches, and as a result the next year five vessels visited these banks.

The schooner *Minnie G. Atkins* in 1867 discovered the Simeonofsky Bank, or what is now known as the Shumagin Bank. It was next visited by the schooner *Shooting Star*, formerly of Vinal Haven, Fox Island, Me., in 1870, and next by the *Scotland* and *Amanda Ager*.[13]

The first fleet of any size to fish around the Shumagin Islands was in 1867 and consisted of three schooners, the *Sanborn*, Captain Morse; the *Porpoise*, Captain Turner; and the *Sarah Louise*, Captain Holcomb. Most of the fish were caught off the western side of Nagai Island, on banks discovered the same season by these vessels.

J. L. McDonald [14] has the following to say as to the influence of the discoveries of these prolific banks in the Gulf of Alaska upon the negotiations for the cession of Russian America to the United States:

In January, 1866, the author, while attending the session of the legislature at Olympia, the capital of Washington Territory, determined to make another bold push for Alaska by soliciting the good offices of our Government for the purpose of obtaining a permanent foothold and to open the prolific fishing grounds in those regions to our ambitious fishermen. To this end we penned the following memorial:

"To His Excellency ANDREW JOHNSON,
"*President of the United States:*

"Your memorialists, the legislative assembly of Washington Territory, beg leave to show that vast quantities of cod, halibut, and salmon of excellent quality are found along the shores of Russian America. Your memorialists respectfully request your Excellency to obtain such rights and privileges of the Government of Russia as will enable our fishing vessels to visit the harbors and its possessions, to the end that fuel, water, and provisions may be obtained; that our sick and disabled fishermen may obtain sanitary assistance, together with the privilege of taking and curing fish and repairing vessels in need of repairs. Your memorialists further request that the Secretary of the Treasury be instructed to forward to the collector of customs of this (Puget Sound) district, such fishing license, abstract journals, and log books as will enable our hardy fishermen to obtain the bounties now paid to the fishermen in the Atlantic

[13] The Cod Fishery of Alaska, by Tarleton H. Bean. The Fisheries and Fishery Industries of the United States, Pt. II, sec. 5, Vol. I, p. 213. Washington, 1887.
[14] Hidden Treasures, or Fisheries Around the Northwest Coast, by J. L. McDonald, p. 11.

States. Your memorialists finally pray your Excellency to employ such ships as may be spared from the Pacific naval fleet in surveying the fishing banks known to navigators to exist from the Cortez Bank to Bering Strait."

This memorial, written by a fisherman in behalf of the fishing industry on the northeast [west] coast, passed both branches of our Territorial legislature with commendable unanimity and dispatch. In forwarding a copy of the above-named memorial to the Secretary of State we imparted such information touching the fisheries around the Russian possessions, and the impulse which the opening of those resources to our fishermen would impart to the commercial development on the northwest coast. In acknowledging our humble services the illustrious Secretary assured us that "in consummating the recent purchase, I was strongly fortified by the letters which you wrote to me touching the valuable fisheries in those waters." The New York Times of April 1, 1867 (the acknowledged organ of Secretary Seward), said "that a memorial from the Territorial legislature of Washington Territory, dated January, 1866, asking the President to obtain certain rights for the fishermen, was the foundation of the present treaty."

On the 18th of October, 1867, the transfer of this vast territory from Russia to the United States was officially consummated by the respective commissioners of the two Governments at Sitka, in the presence of the Russians population, who cheerfully welcomed the few Americans there also present. The union has been very cheerfully accepted by the people of the Territory. Our Government, on assuming possession, found numerous adventurers from the Pacific States domiciled in various parts of the Territory engaged in trade and in developing the resources in those regions; vessels laden with ware entered every harbor; stores were opened as by magic in every acceptable roadstead along the southern and western coasts; an active competition for furs, oil, ivory, old copper, iron, and junk was earnestly inaugurated; commerce revived, the sails of our vessels whitened every creek, bay, and sound, and the staid Russians very soon obtained an insight into Yankee progress on the go-ahead principle.

The acquisition of Alaska by the United States in 1867 proved an especial boon to our cod fishermen, as it secured them from any interference on the part of the Russians, who had not welcomed them very heartily in previous years. This is well shown by the fact that while the fleet in 1867 numbered 3 vessels, the fleet of 1868 comprised 14 vessels.

The first vessel to attempt to make two trips in one season was the schooner *Porpoise*, Captain Caton, in 1868, but she got only half a fare on the second.

The first Alaska vessel in the fishery was one owned by Captain Haley, of Wrangell, who in 1879 visited the Hoocheno Bank, in Chatham Strait, southeast Alaska, and purchased his fare from natives who claimed the exclusive right to engage in the fishery. These fishermen used bark lines, with wooden iron-pointed hooks, and, as they considered a catch of 30 or 40 fish a good day's work, Captain Haley had to wait quite a while before he could accumulate a cargo. In later years several vessels engaged in the business along the same lines as Captain Haley.

An odd feature of the Pacific cod fisheries is that neither Portland nor Astoria have ever had vessels engaged in it. In 1877 Capt. Joshua Slocum, with the schooner *Pato* (about 45 tons register), was at the Philippine Islands, when he conceived the idea of making a cod-fishing voyage to the Okhotsk Sea and marketing his catch at the islands. Leaving the islands in March, he proceeded to the Okhotsk via Yokohama. Salt and fishing gear were obtained from vessels met at sea, and a cargo of 23,000 fish was soon taken. When the time for sailing arrived the captain decided not to return to the islands, but took his fare to Portland instead, where he sold it at a

profitable price. This was the only fare of cod to be landed at Portland.

For the first few years of the fishery no suitable facilities were in existence at San Francisco or elsewhere on the coast for curing the fish. In certain cases the fishermen received their share of the voyage in fish, which, after being cured in a good, bad, or indifferent manner by themselves, were hawked around the city.

The late Thomas W. McCollam, of San Francisco, enjoyed the distinction of having been the first man on the Pacific coast to establish the industry on a permanent basis. In 1867 he bought his first cargo of cod, and the next year he bought and cured several cargoes at Old Sausalito, but as this locality was not satisfactory he soon after established a new station at the mouth of Redwood City Creek, about 30 miles south of San Francisco.

Having decided to engage directly in fishing himself, Mr. McCollam went east in 1868, and in New England purchased the fishing schooners *Rippling Wave*, *Wild Gazelle*, and *Flying Mist*. The first was lost on the passage in Magellan Strait; the others arrived safely and were outfitted immediately and sent north to the Shumagin Islands for cod. In addition to handling his own fish, he also continued to buy the cargoes from other vessels.

In 1873 a partner was taken into the business and the firm was then known as Thomas W. McCollam & Co. In 1874 the schooner *Alfred Adams* was added to his little fleet, while the *Flying Mist* went sea-otter hunting on the Asiatic shore.

In 1876 the firm again changed the location of its home curing station, removing to Pescada Landing, opposite Sausalito, on Richardsons Bay, where its successor, the Union Fish Co., still carries on the business. In 1883 several new members were admitted into the firm and its name changed to the McCollam Fishing & Trading Co.

The first shore fishing station for cod in Alaska was established by this firm at Pirate Cove, Popof Island, in the Shumagin Group, in 1876, a more detailed description of which will be found in the chapter devoted to the history of the shore fishing stations in Alaska.

In 1893 the Pacific Marine Supply Co. was organized in San Francisco for the purpose of engaging in cod fishing and the carrying on of other business. The first published record we have of the company engaging in cod fishing was in 1896, when the former whaling schooner *La Ninfa* (also given as *LaNympha*) was outfitted and sent to Bering Sea. In 1904 the name was changed to the Alaska Codfish Co., and the business has been operated under this name since. In addition to a fleet of vessels the company also owns and operates a number of shore stations in Alaska.

In 1898 a combination of several San Francisco firms operating in the cod fishery, notably the McCollam Fishing & Trading Co. and Lynde & Hough, was formed and the name Union Fish Co. was selected for the new company.

From the very beginning San Francisco has occupied the premier position in the fishery; in fact for many years it was the only place on the coast where cod vessels were outfitted. The industry fluctuated much and the changes in the personnel were frequent. The late Charles P. Overton, for many years before his death connected

with the Union Fish Co., and one of the brightest men engaged in the industry, has written considerable upon the early history of the San Francisco fleet, and the author quotes from his writings as follows:

While making a review of the past years in the codfish business, probably the most interest would lie in recalling the names of those who have been prominently identified with the industry. Considering the few years that the business has been carried on and the restricted nature of it, the list is a surprisingly long one, and is one that should be published as a record to be preserved among the archives of the industry.

First, there was Captain Turner himself. Like most pioneers he did not make much of a financial success of it and soon abandoned it to others.

Sometime previous to 1870 Miller & Hall, the hay merchants, sent the brig *I. B. Lunt* two or three times. The fish were sold by Lynde & Hough, but the returns did not pay cost and interest and they dropped out.

FIG. 4.—Union Fish Co.'s home station at Union City, San Francisco Bay, Calif.

Andrew Crawford, the ship chandler and Tahiti trader, had a schooner in the codfisheries previous to 1870. From 1870 to 1873 he operated the bark *Legal Tender*, Captain Wentworth. At first there was a profit, but the last two years were so unfavorable that Crawford withdrew from codfishing and turned his entire attention to the South Sea trade.

Donald Beadle was one of the prominent figures "on the front" in the early days having interests in the commission and shipping business, and in the old firm of Goodall & Perkins, and with Moss in some of the southern coast landings. Like everybody else on the front he had his turn at the codfish fever and was interested in the voyages of the *Bernice*, *Kinau*, and bark *Union*. At that time the fish were all cured direct ex-vessel and so many spoiled before they were sold that the losses were considerable.

Captain Wing, backed by the funds of his son-in-law, Bailey Sargent, of the American Exchange, bought the little bark *Domingo*, and the captain became a codfisher. With an occasional diversion to South Sea trading, he fished with more or less regularity for five or six years, Sargent backing the ventures until the captain died, practically of old age.

Col. C. L. Taylor dipped in as a venture about 33 years ago, and he still refers sadly to what it cost him for his experience.

In 1874 and again in 1876 a Captain Jacobsen sent the little schooner *San Diego* to the Choumagin Island grounds under Captain Wentworth. Two voyages were enough; then he sent her sealing. Explaining the change, he said: "Well, Captain Wentworth is a goot mon, but he is too expensible."

James J. Laflin, or, as everybody "on the front" knew him, Jimmy Laflin, a sailor boarding-house keeper, who would furnish a crew for any vessel "and no question asked," operated the schooner *Alaska* in the codfisheries during the seasons of 1876–1879. The first two years the cargoes arrived on a bare market and the profits were good—good enough to induce such an increased catch by him and others as swamped the market, and after the two years of good business and then two years of correspondingly bad business, Jimmy diverted his vessel into other trade, and she was finally lost in the Bering Sea bringing down a company of Alameda mining men from Golovin Bay.

Johnston & Veasey (1877–1879) were among the old-timers at it. They held on for three years. Veasey, later, drifted into a small produce business and died poor many years ago. Captain Johnston got down to going to sea again on monthly wages and then drifted around the water front looking for a berth of some kind and finally disappeared.

Another of the old-timers (1879–1884) was John Molloy, the junk and second-hand man of Clay Street, with the old brig *Glencoe* in the codfish business as a side issue. Like everything else that old John had, the vessel was poor, the salt was poor, and the fish were, of course, yellow or sour, dried up or slimy, but they went onto the market and helped damn Pacific codfish. Old John had a brother-in-law, a wealthy wholesale grocer, who furnished checks to keep him going. When the brother-in-law withdrew his support, old John went around town, bought everything he thought his credit would stand, and quietly went into bankruptcy—paying nothing on the dollar. He is dead and doubtless gone to his just reward. Any unkindness I may feel toward old John may possibly be because we were on the list of creditors when the end came.

From 1882 to 1888 Ed. H. Hansen, of Wright & Bowne, and Capt. A. Anderson, now of the Lewis, Anderson, Foard Co., with some others, operated the schooner *Isabel*, Captain Nickerson, in this business. For the first two or three years they caught the market short and did so well that they added the brig *W. H. Meyer*. But about this time the production began to exceed the demand, and they soon had to drop out the brig. Business became so poor they did not keep the old *Isabel* in good repair, and in the spring of 1888, while on her way to the fishing banks, she opened up somewhere out at sea. As many of the crew as could do so got into the dories, and after suffering many privations about half of them were rescued more nearly dead than alive. This ended the venture, and the partners paid up their losses and quit.

In 1883 Higgins & Collins, the wood and lumber men, with Wheeler Bros., small tugboat men, fitted out the schooner *Bonanza* on an eastern basis, importing eastern fishermen and eastern gear. They cured their fish on the deck of the vessel in Oakland Creek, and when they closed up their accounts each of the partners was an even $2,500 to the bad. That schooner *Bonanza* had an eventful and varied career. Built in 1875 as a yacht for William C. Ralston, the brilliant but unfortunate manager of the Bank of California, she has been freighter, trader, codfisherman, and finally as a whaler was crushed in the ice last year in the Arctic near Herschel Island. The story of her voyages to the remote and unfrequented waters of the North and South Pacific, the Behring Sea, and the Arctic Ocean would be worthy the pen of Robert Louis Stevenson.

In 1886 James Madison and some of his associates fitted out the schooner *Francis Alice*, and also started a little station at Ikatok in Alaska. The fish were offered on the street by Frank Bates, a broker, but the trade was filled up by the old companies. and the fish found such slow sale that the whole cargo was bought in by this company at a very low price. We later took over the station, and the schooner and the business was entirely closed out. Like a butterfly, it lived but one summer.

In 1894 a Captain Jorgenson bought the condemned steamer *Salinas*, converted her into a three-masted schooner, rechristening her the *Uranus*, and sent her codfishing. He did fairly well for two years then, with the backing of the firms outfitting him, he added the *W. F. Harriman*, also a condemned hull refitted. At the end of the third year his whole oufit passed into the hands of those who had been backing him, and he was known in the codfiish business no more.

Young Duggan (1902) had a short and inglorious career as a codfish man, and some of the money that his father made in the shirt business went to pay what it cost the young man to listen to the siren song of the wily promoter. The schooner *J. G. Wall* went to the Bering Sea under the joint command of Captain Dollard (the promoter) and Henderson (an experienced codfisher). We bought their season's catch, and it lasted us just three days. One season was enough for Mr. Duggan.

Undoubtedly the most picturesque figure in the whole line was Nick Bichard. A native of the Isle of Jersey, a pioneer shipowner and merchant of San Francisco, he accumulated a fortune during the days of the Civil War and was early in the codfish business with quite a fleet of old vessels, both large and small, and for many years he was a prominent factor in the business. A large, swarthy man, erratic in speech and action, mixing codfish, coal, lumber, and junk, keeping most of his books in his head, he never knew what his cargoes cost him nor what they sold for. The codfish business absorbed more and more of his capital; then his real estate, two fine water lots on Stuart Street, the gore lot at California and Market Streets, and other property went the same way; the old vessels wore out and were lost and he finally died peacefully in the night of heart failure, leaving barely enough to bury him.

Chief among the old-timers and of those most largely interested and longest in the business was the firm of Lynde & Hough, two enterprising Yankees of the old school who started in Sacramento in pioneer days, came down to San Francisco, were in the commission business and, from selling codfish on commission, drifted into the codfishing business [in 1865] itself. There were for many years among the heaviest operators in codfish and, in addition, they dealt in all other kinds of salt fish, cornered the honey market, dipped into sealing in the Straits of Magellan, South Sea Island trading, fishing and trading stations in Alaska, salmon fishing, freighting, running a coasting passenger steamer, and anything else that promised a dollar, including "Okhotsk Sea Cod liver Oil" and "Dr. Fisherman's Lotion for Man and Beast." They and their surviving partner, L. E. Noonan, were well and favorably known from Alaska to South America and from Hawaii to Australia and the Orient. Their last venture was codfish mixed with mining, and finally both of the senior partners died, leaving no money but various debts behind them. Their location at California City was sold to the United States Navy Department for a coaling station, and their vessels and codfishing business were merged in the Union Fish Co.

L. E. Noonan was connected with the Lynde & Hough company for nearly 40 years, at first as general factotum and handy-man-ready-for-anything. He ran the fish yard, outfitted the vessels, hired captains and crews, packed and repacked salmon and mackerel, bought and sold on the street. Later he acquired an interest in the firm and, being of a more thrifty disposition and not interested in the mining, he was enabled to retire with enough to permit him to take a well-earned rest.

These epitaphs of those who have dropped into the business and then dropped out run in schools. Their course is something like this: The bright sun of prosperity shines for a season or two upon the regular stand-bys in the business and it looks very attractive and inviting to some chaps with an old vessel or a little spare money. So they jump in and for a time cut a brilliant dash in the business. So bright are they that the sun of prosperity is all in eclipse and everyone in the trade walks in a shadow. When they get tired of this or broke they drop out, and those who are left pick up the scattered ends of the trade, struggle out into the light again, and by and by there is some more prosperity and then a new crop of hopeful investors appears, and so on and on.[15]

One of the most picturesque figures in the industry, and one who cut a wide swath while in it, was Edward Pond. Beginning in 1902, with apparently no end of money, he sent two vessels to Bering Sea. In 1905 his fleet had increased to three vessels, two of which fished in the Okhotsk and one in the Bering Sea. Prices for fish were low in 1906 and 1907, and when the two vessels he had sent to the Okhotsk Sea in the latter year returned virtually empty, having been driven

[15] Pioneers in the Pacific Coast Codfish Industry, by C. P. Overton. Pacific Fisherman Annual, 1906, pp. 70, 71, and 75.

from the sea by the Russian authorities, he was forced to the wall, and his stock of fish on hand and to arrive was taken over by the Union Fish Co.

In 1905 the Pacific States Trading Co. was organized at San Francisco. A home-curing station was built on Carquinez Strait, about 30 miles from San Francisco, and named Woodside Glen. The schooners *Glen* (121 tons) and *John F. Miller* (170 tons) were sent to Bering Sea. The company also built several shore stations in Alaska, as noted elsewhere. Later the company added the schooners *Ottillie Fjord* (247 tons) and the *Dora Bluhm* (315 tons) to its fishing fleet. On September 30, 1907, the schooner *Glen* was lost on Unimak Island, with the loss of one life. While the schooner *John F. Miller* was engaged in an attempt to save the wrecked schooner a gale suddenly sprang up on January 8, 1908, and she was also driven ashore, 10 of her crew losing their lives. This disaster to two of its fleet, together with a heavy overproduction in 1908 causing a slump in the market, compelled the company to cease operations for a season or two. In 1909 the company's schooner *Ottillie Fjord* was outfitted and sent north by the Union Fish Co. In 1910 all operations were suspended, but in 1911 the company resumed operations at its shore station in Northwest Harbor, and also outfitted and sent north the schooner *Otillie Fjord*, and operated continuously until early in 1916, when the company finally abandoned the business.

For a number of years the majority of the San Francisco vessels resorted to the Okhotsk Sea for their cargoes of cod, and in some seasons nearly all of the vessel fishing was prosecuted there. In 1892 the Russian Government began to enforce a regulation imposing a license on all vessels fishing within 30 miles of shore, and from this time on the American vessels experienced alternate periods of harassment and quiet, according as the disposition of the Russian governor was toward lax or rigorous enforcement of the regulation. A typical instance of such harassment is cited by Wilcox.[16]

> The three-mast schooner *Hera*, 369 net tonnage, of the San Francisco codfish fleet, was the only American vessel that fished in the Okhotsk Sea. Her catch was all made from 10 to 30 miles from the shore. While fishing, the vessel was boarded by a Russian officer, who ordered that fishing cease and that the vessel report at once to the governor of the district and there procure a license. The master of the *Hera* denied that he was fishing in waters of Russia, as he was fully 10 miles from shore. The officer threatened to seize the vessel if his order was not obeyed. The master complied, and on reporting to the governor again protested as to his having any legal right or authority to interfere with him when fishing so far from land, no fishing having been attempted under 10 miles from shore. As before, a protest was not recognized, and $1,000 in gold was demanded for a license that must be procured before the vessel would be permitted to leave the port. A compromise was made by the master giving, under protest, his personal order for $1,000 on the owners of the vessel at San Francisco. The vessel then returned to the fishing grounds, completed her cargo, and returned to San Francisco with a catch of 159,000 codfish, of a net weight of 685,140 pounds. The order given by the master was forwarded to the Russian consul at San Francisco for collection; but the draft having been given under compulsion its payment was refused.

In 1907 matters began to assume a serious aspect. That year the following vessels had visited the Okhotsk Sea: The schooner *John*

[16] Notes on the Fisheries of the Pacific Coast in 1895, by W. A. Wilcox. Report of United States Commissioner of Fish and Fisheries for 1896, pp. 634, 635. (1898.)

D. Spreckles, the barkentines *Fremont*, *City of Papeete*, and *S. N. Castle*. Shortly after the vessels arrived and began fishing the Russian gunboat *Mandjur* appeared, and an officer boarded the *John D. Spreckles* and *S. N. Castle*. Taking their papers, the commander ordered the vessels to quit fishing, claiming they were within the 30-mile limit, and threatening to seize the vessels if they did not. As a result the vessels left the sea and returned to San Francisco almost empty.

A few days later, on June 12, the gunboat met and boarded the *Fremont* and seized her papers, also.

On June 19 the gunboat came alongside the *City of Papeete*, and the Russian commander seized her papers and ordered her to quit fishing. Captain Stensland, the master of the *City of Papeete*, went aboard the Russian patrol boat and showed her commander a copy of an opinion written several years before by John Hay, while Secretary of State, to the effect that under international law the vessels of any nation had a right to fish at any point 3 miles or more offshore. In anticipation of just such a happening this copy had been furnished to the master by A. Greenebaum, president of the Alaska Codfish Co., owners of the vessel. Secretary Hay's opinion seemed to have considerable influence with the officer, who at once steamed to the mainland to seek advice from his superior officers. On July 10 he returned and restored the ship's papers to the master, admitting that the 30-mile limit for fishing was not to be enforced.

On July 12 the Russian gunboat steamed alongside the *Fremont* and restored not only her own papers but also those of the *John D. Spreckles* and *S. N. Castle*.

In 1908 a fleet of three vessels fished in the Okhotsk Sea, while in 1909 only the barkentine *Fremont* fished on these banks. The latter vessel's master reported a considerable fleet of Japanese vessels fishing there for cod. This was the last season in which American vessels visited the Okhotsk Sea for cod.

In 1891 Capt. J. A. Matheson, of Provincetown, Mass., who had been engaged in the Atlantic codfishery for a number of years, sent his schooner *Lizzie Colby* around the Horn, coming himself by rail and establishing himself at Anacortes, Wash., and sent his vessel to the Alaska banks, this being the first venture on the coast other than from San Francisco. In 1905 the schooner *Fanny Dutard* was added to his fleet. In 1906 the schooner *Lizzie Colby* dropped out. In 1908 the schooner *Harriet G.* was purchased, and it and the *Fanny Dutard* sent north. In 1909 the same fleet was sent north, but in 1910 only the *Fanny Dutard* was outfitted. San Francisco parties, as noted elsewhere, purchased the plant and fleet in 1910, incorporated it as the Matheson Fisheries Co., and installed Captain Matheson as manager. In 1912 he dropped out altogether, but late in 1914 purchased the fleet of the Matheson Fisheries Co.—the schooners *Azalea* and *Fanny Dutard*—and sent it north under his own name in 1915.

The Puget Sound & Alaska Commercial Co. was the pioneer in the cod-fishing industry from Seattle, Wash. It began operations in February, 1892, and on March 5 dispatched the schooner *Moonlight*, of 68 tons, to the Bering Sea banks. The vessel returned on August 20 with 175,000 pounds of salt cod. No more is heard of the company after this first venture.

In 1896 Tracy H. Robertson organized the Oceanic Packing Co., with headquarters in Seattle, and outfitted and sent to Bering Sea the schooner *Emma F. Harriman*. She returned with a full cargo, but as the demand in the Northwest for cod was quite slack, the vessel was sent direct to San Francisco and the cargo sold there.

In 1897 the company sent to Bering Sea the brigantine *Blakeley* and the schooner *Swan*. The vessels returned with full cargoes, and these were prepared for market at a plant the company had built in West Seattle.

The Klondike rush had begun in 1897, and in 1898 the company became interested in the transportation business and diverted its vessels into this industry, in the course of which the schooner *Swan* was wrecked. In 1899 and 1900 the brigantine *Blakeley* was sent to the Bering Sea banks by the company, and returned each season with full cargoes. The business had not proved very profitable, however, and the company ceased operations in the latter year.

In 1898 Mr. Fay, a Seattle lawyer, sent the schooner *Lizzie S. Sorrenson* (89 tons) to Bering Sea. She returned with a full cargo and the fish were worked up at a plant built at Richmond Beach. The venture could not have been very profitable, as only the one trip was made. The *Lizzie S. Sorrenson* was a comparatively small schooner and her chief title to fame rests upon the unusual fate she eventually met. In 1909 the Tyee Co., which then operated a shore whaling station at Tyee, southeast Alaska, purchased the schooner, which was thereupon fitted with a gasoline engine and turned into a whaler. On May 10, 1910, a whale was sighted in the ocean about 8 miles southwest of Cape Addington. The vessel was cautiously worked to within gunshot and a harpoon driven into the animal. The weapon failed to reach a vital spot, and after an effort to escape the gigantic mammal turned suddenly and, charging the vessel, struck her full in the stern. The impact knocked out a portion of the vessel's bottom and she sank in a few minutes.

The Seattle-Alaska Fish Co. began business in Seattle in 1902, using for its home station the old West Seattle plant of the Oceanic Packing Co. The first year the schooner *Carrier Dove* was the only vessel outfitted, but in 1903 the schooner *Nellie Colman* was added. In 1906 the latter vessel was sold, her place being taken by the schooner *Maid of Orleans*. Only the *Carrier Dove* was outfitted in 1907, but in 1908 she was sold and the *Maid of Orleans* outfitted. In 1910 the company was absorbed by the King & Winge Codfish Co., of Seattle.

In 1904 the late W. F. Robinson, who had been connected with the New England fisheries for a number of years, and others bought the schooner *Alice* and, under the name of the Schooner Alice Co. (Inc.), sent her north. In 1905 the corporate name was changed to the Robinson Codfish Co., the schooner *Joseph Russ* purchased, and a large plant constructed at Anacortes, Wash. In 1911 the original plant was sold and another erected at once on the company's property in connection with a by-products plant that they owned. In 1912 the name of the company was changed to the Robinson Fisheries Co. On April 20, 1912, the schooner *Joseph Russ* was lost on Chirikoff Island, Alaska. In 1914 the schooner *Wawona* was purchased. and the same year she brought home the largest trip of cod—240,000 fish weighing about 1,100,000 pounds—ever caught and landed from

an American vessel up to that time. In 1915 she broke her 1914 record with a catch of 258,323 fish, weighing approximately 1,150,000 pounds.

In 1904 the late Andrew Webber, of Seattle, made a venture in the industry by sending to Bering Sea the little schooner *Ida May*, and repeated it the next season, after which he withdrew.

In 1905 the King & Winge Codfish Co., composed principally of King & Winge, the well-known shipbuilders of Seattle, sent the schooner *Harold Blekum* (185 tons) to the Bering Sea banks and continued doing so, adding the schooner *Vega* later, until 1910, when the company joined the consolidation known as the Western Codfish Co. The company had its home-curing station located in West Seattle.

The Blom Codfish Co. was organized in Tacoma in 1905 and sent the schooner *Falcon* (195 tons) north, in the meantime building its home-curing station at Quartermaster Harbor. The company had a very checkered career, finally ceasing business in 1914, when its assets, including the schooner *Fortuna*, passed into the hands of Seattle parties, who organized the Northern Codfish Co. for the purpose of carrying on the business. The latter company sent the vessel north in 1915, but dropped out of the business early in 1916, the schooner being chartered to the Pacific Coast Codfish Co.

The Pacific Coast Codfish Co. was formed in 1911 by former stockholders of the Seattle-Alaska Fish Co., which had been sold to the King & Winge Codfish Co. The company constructed a home-curing station at Poulsbo the same year and sent north the schooner *John A.* In 1913 the schooner *Chas. R. Wilson* was added, and in 1914 the schooner *Maid of Orleans*, while in 1915 the schooner *Fortuna* was chartered and added to the fleet.

In 1910 T. Tilmann, jr., of the firm of Tilmann & Bendel, and other San Francisco parties, none of whom had been engaged in the business heretofore, attempted to form a consolidation of the Puget Sound companies. A controlling interest was secured in the King & Winge Codfish Co., and this company then purchased the Seattle-Alaska Fish Co. The two properties were then merged under the name of the Western Codfish Co. The property of Capt. J. A. Matheson was purchased, and it was incorporated under the name of the Matheson Fisheries Co., with Captain Matheson in charge of operations. In the meantime the Union Fish Co., of San Francisco, purchased the cargoes of the schooners *Joseph Russ*, *Alice*, and *Fortuna*, the two former belonging to the Robinson Fisheries Co. and the latter to the Blom Codfish Co. The Western Codfish Co. had but a brief existence, dropping out of active fishing operations early in 1912, while in December, 1914, Captain Matheson bought from the Matheson Fisheries Co. the schooners *Fanny Dutard* and *Azalea* and sent them north in 1915 under his own name. After disposing of its 1914 catch the Matheson Fisheries Co. wound up its active career in the summer of 1915.

Early in 1917 the Northern Fisheries Co., a new company with headquarters at Anacortes, Wash., was organized, and in January sent out the old codfish schooner *Harold Blekum*, with material for a shore station to be erected on Kodiak Island. On the night of

March 3 the vessel went on the reef at Eagle Harbor, Kodiak Island, and was a total loss.

The same company also sent north the former halibut power schooner *Progress* (115 tons), schooner *Chas. Brown* (64 tons), power schooner *Valdez* (10 tons), and the power schooner *Hunter* (60 tons) to engage in fishing operations. The latter vessel, however, was wrecked on Sutwick Island on August 30, and, together with its cargo of codfish, was lost.

In 1918 this company purchased the controlling interest in the Union Fish Co. of San Francisco. In 1919 the Anacortes plant was closed, and after this operations were carried on at the San Francisco plant of the Union Fish Co.

In 1918 Lars Mikkelson organized the Bering Sea Fisheries Co. and built a station on Unalaska Island. The former mail steamer *Dora* (217 tons) was purchased and sent north to engage in fishing operations and to bring down to the home station (that was later established at Dockton on Puget Sound) its own catch and that of the fishermen at the station. On December 20, 1920, the steamer *Dora* struck on Noble Island and was beached on Vancouver Island, British Columbia, only a short distance away. She was salvaged subsequently and sold elsewhere.

The first Canadian company to engage in cod fishing on the Pacific banks was the Western Canadian Fish Co. This company built a home station at Barnet, British Columbia, in 1903, and sent the brigantine *Blakely* to Bering Sea. The company struggled along until the latter part of 1905, when it went out of the business.

In 1913 the Canadian Fish & Cold Storage Co., of Pince Rupert, British Columbia, outfitted the schooner *Albert Meyer* and sent her to the Bering Sea banks. She arrived there at almost the end of the fishing season, and as a result brought back but a few hundred fish. The vessel made another trip in 1914, when it met with fair success. As the market was very poor when she returned the company gave up this branch of its business.

HISTORY OF ALASKA SHORE-FISHING STATIONS

The natives living in the vicinty of the great cod banks of Alaska have depended upon them for a considerable part of their food supply, although not to such an important extent as they have upon the salmon. When the Russians came more and more home use was made of cod, and the same is true of their creole descendents to-day. With the exception of a few small shipments made from Kodiak in the early years of the industry, the catch of the natives and few whites living at other than the regular cod stations has all been consumed locally.

The late Thomas W. McCollam, of the McCollam Fishing & Trading Co., of San Francisco, was the first to perceive the advantages to be obtained from establishing stations close to the cod banks where the fishermen could go out daily in dories to the adjacent banks and the catch be stored ashore until a cargo accumulated, when a vessel could be sent north to bring them to San Francisco.

Early in the seventies a party of hunters had established a station at Pirate Cove, a very pretty and well-sheltered cove, with ample

depth of water, at the north end of Popof Island, one of the Shumagin Group. A wharf and several buildings had been constructed by the party. Mr. McCollam purchased this station and established here the first regular shore fishing station for cod in Alaska.

An agent and about eight fishermen were stationed here during the early years of its existence. At first the fish were all kenched, but later on tanks were sent up and the fish held in pickle until shipped. The station gradually increased in size and importance, and to-day, as well as in the past, is the largest and most important one in Alaska.

In 1886 a branch fishing station was established on Pavlof Harbor, Sannak Island. In 1890 a station was opened at Kasatska, on

FIG. 5.—Pirate Cove, the pioneer codfish station of Alaska

the south side of Sannak Island, and was operated for several years, finally being abandoned because of the dangerous navigation for sailing vessels on that shore. The Port Stanley (Sannak Island) station was established in 1891 but was abandoned a few years later. All of these were what are known as " winter stations "—that is, stations operated in what are known as the winter months in Alaska; during the rest of the year the fish are too far out in the deep water for fishing with dories with the shore as the base.

In 1892 a station was established on Sanborn Harbor, Nagai Island, Shumagin Group, and this has been operated almost continuously ever since. Fishing is carried on here from the middle of spring to late summer.

In 1883 Ivan Petroff built a fishing station on Sitkalidak Island, close to the Indian village at Old Harbor, on the channel separating

Sitkalidak from Kadiak Island, where for a time considerable quantities of cod were cured and shipped to San Francisco.

In 1886 James Madison and associates, of San Francisco, fitted out the schooner *Francis Alice*, and also started a small station at Ikatak, on Unimak Island. The venture lived but one season, the station then being taken over by the McCollam Fishing & Trading Co.

Lynde & Hough, a well-known San Francisco firm, early entered the codfish industry and for a number of years were important factors in it. Besides a fleet of vessels the firm established a number of shore stations in Alaska. The earliest of their stations was at Sand Point, on Humboldt Harbor, Popof Island, in the Shumagin Group. This was in 1887. It was established principally as a trading and salmon-fishing station, its relation to the codfish industry being mainly as a supply station where the firm's vessels could land their cargoes and refit for another trip without having to return to the home port for this purpose.

The firm built a number of shore stations shortly after this—Unga Harbor (1888 or 1889) and Squaw Harbor (1889), on Unga Island; Henderson Island (1889), in the Shumagin Group; Company Harbor (1889) and Nelson Island (1890), in the Sannak Islands; Chicago Bay (1890), Alaska Peninsula, and Ikatak (1890), on Unimak Island. Several of these had but an ephemeral existence, as Chicago Bay, Nelson Island, and Henderson Island.

About 1898 the McCollam Fishing & Trading Co. and Lynde & Hough formed the Union Fish Co. as a selling agency for their product. It was not until 1902 or 1903, however, after the death of both Lynde and Hough, that the two concerns finally were merged into one and the whole business operated under the name of the Union Fish Co.

In 1876 A. Greenebaum, then and for a number of years subsequent agent for the Alaska Commercial Co., built a trading station for the company at Acherk Harbor (later known as Company Harbor) on Sannak Island. A little codfishing was prosecuted at times, but it was not until 1896, when it became the property of the progenitors of the Alaska Codfish Co., that it was used for this business exclusively. In 1897 the company established another station on Moffet Cove, a few miles east of Company Harbor.

In 1896 the Alaska Codfish Co. opened its Kelleys Rock station, situated about midway between Unga and Squaw Harbors. This, like the Unga station, is an all-the-year-round station and is by far the most productive one owned by the company.

In 1906 the Alaska Codfish Co. bought the Alaska Commercial Co.'s station at the town of Unga, on Unga Island, and began fishing operations in the fall. The next year the Union Fish Co. built a station here, but on the opposite side of the harbor. Fishing is carried on here throughout the year.

The present Squaw Harbor station of the Alaska Codfish Co. was first established as a salmon saltery by a man named Olsen, who also utilized it at times as a codfish station. In the summer of 1903 the present owners purchased it and have very much improved it since. It is a winter station. Its principal use to the company is as a supply depot for its near-by stations, the harbor being one of the safest in the Shumagins.

The Dora Harbor, Unimak Island, stations of the Alaska Codfish Co. and the Union Fish Co. were established in 1897 and 1898, respectively. While they were quite productive the first two seasons, they have been steadily diminishing in importance ever since. The Sannak Island station men are transferred to these stations in the spring, after the cod have moved off into the deep water surrounding Sannak Island, and are brought back again in the fall when the fish have again returned to the shoal waters.

About 1903 the Union Fish Co. built a station at Wedge Cape, Nagai Island, and operated it intermittently as a summer station until 1909, when it was abandoned.

In 1903 the Union Fish Co. built a station at Eagle Harbor, on Nagai Island, and operated it continuously up to and including

FIG. 6.—The town of Unga, Alaska, with the Alaska Codfish Co.'s station in the foreground

1909, since when it has been shut down owing to the difficulty of securing enough men to work it.

The first Puget Sound company to establish a shore station in Alaska was the Seattle & Alaska Fish Co., of Seattle, which built a station at Falmouth Harbor, on Nagai Island, in the spring of 1903. As this proved to be too far from the fishing grounds, the station was moved almost immediately to Squaw Harbor, on Unga Island. In place of the dories used at other stations, this company equipped the plant with Columbia River boats, two to four men going in each. The station was worked intermittently until 1910, when the company sold out to the King & Winge Codfish Co., which ultimately merged into the Western Codfish Co. It has not been operated since, owing mainly to its remoteness from the fishing grounds. It is now the property of John H. Nelson.

In the fall of 1902, John H. Nelson and John Einmo opened a shore station at Hard Scratch, on Snug Harbor, Unga Island, but operated it only one winter. In the fall of 1911 R. H. Johnson established a shore station here and has operated it ever since.

In the fall of 1905 the Blom Codfish Co., of Tacoma, Wash., built a station on the north shore of Eagle Harbor, Nagai Island, and operated it for a couple of years, when it was abandoned.

In the fall of 1905 the Pacific States Trading Co., of San Francisco, which had just recently started in business, established stations on Herendeen Island, Northwest Harbor, and at Ikatak, on Unimak Island, and operated them continuously until 1909. The latter station was not reopened, but operations were resumed at the former in the fall of 1911, and it was operated until early in 1916, when the company suspended operations and sold the station to the Union Fish Co. The Ikatak was a summer station, while the one at Northwest Harbor is a winter station.

In the summer of 1908 John H. Nelson, who had opened a station at Hard Scratch in 1902, started a station on Squaw Harbor and operated it every year until his death, when it passed into other hands. In the earlier years of its existence stockfish formed the bulk of the product, but during the last few years considerable dried salt cod has been prepared.

In 1914 A. Komedal, a merchant of Unga, established a station near that town and has operated it during the greater part of the time since.

In 1910 the Alaska Commercial Co. shipped to San Francisco aboard one of its regular trading vessels about 90 tons of cod that had been caught and cured by the natives of Kodiak. The fish proved to be quite small, and the company had so much difficulty in disposing of them that it did not repeat the experiment.

In subsequent years occasional lots of cod were caught by fishermen living on Kodiak Island and were cured and shipped to Puget Sound dealers, but the industry did not amount to much until 1917, when the Northern Fisheries Co., with headquarters at Anacortes, Wash., established a shore station on Kodiak Island and carried on operations here and also with a small fleet of vessels.

The demand for cod engendered by the World War by this time was felt all over the world, and the high prices realized drew a large number of Kodiak fishermen into the business; and until the collapse came in 1921, a small fleet of vessels, mainly powered with gas engines, and a considerable number of small sail and power vessels of less than 5 net tons each, operated on the banks lying off the east coast of the island, using the town of Kodiak as headquarters and shipping the cured catch to Washington ports through local dealers.

The demand for cod created by the war also led to the establishment of numerous small local stations scattered along the Alaska Peninsula and the numerous islands lying to the south of these and on the Aleutian chain. Unalaska, owing to its shipping facilities, was the center for several of the more important. When the slump came after peace was declared, most of these stations shut down and but few have since resumed operations.

During the summer of 1916 the Union Fish Co. established a new shore station on Tigaldi Island, which lies just off the entrance to

Unimak Pass, while in 1918 the Bering Sea Fisheries Co. opened an important station on Unalaska Island.

A notable feature of the industry in recent years has been the large number of individuals and meagerly financed companies preparing stockfish for the market. This work is carried on mainly during the winter months, when fishing for other species than cod is suspended. It requires but little capital, and as the demand in Washington has been fairly good, it has proved a remunerative source of income to the more energetic fishermen. The following statistics show the fluctuations in this branch of the industry in recent years:

Year	Pounds	Value	Year	Pounds	Value
1916	36,800	$5,990	1921	678,422	$74,626
1917	69,700	12,400	1922	64,000	9,600
1918	38,286	7,128	1923	39,800	5,970
1919	29,000	700	1924	39,300	5,869
1920	12,775	2,300			

In 1923 the San Juan Fishing & Packing Co. opened a shore station at Unalaska, and also has the power schooner *San Jose* (14 net tons), formerly engaged in halibut fishing, operating with the station as her base.

PERSONS EMPLOYED

With the exception of the owners, a few of the higher officials ashore, and several of the captains, but a small number of those engaged in the industry are native Americans. The large majority are of Scandinavian birth, with a few Finns, Germans, Canadians, etc. At the stations quite a few natives are employed as fishermen. No orientals are employed except occasionally as cooks at the stations.

The captains and mates of the vessels are almost all men who have worked up from the ranks of the fishermen. Operating on the codfish banks of Alaska requires considerable local knowledge of the banks, of the prevailing winds, and also of the most convenient spots for shelter and for water. While the majority of them are good navigators, a few are sadly deficient in this respect, yet their knowledge of Alaska conditions enables them to make about as many successful trips as their fellows who are better grounded in the science.

The men in charge of the stations are generally fishermen who have worked up from the ranks. While some of these men are excellent workers, with considerable native shrewdness, yet as the necessities of the industry require their constant presence in Alaska, they get very little opportunity to keep in touch with the world's progress, and generally continue throughout their business life to carry on business in the same old groove in which it was running at the time responsibility fell upon them. They are also a very poorly paid class of men, with virtually no opportunity for advancement beyond the position of station agent. This largely explains why the codfish industry of the Pacific coast is but little further advanced to-day, so far as methods of catching and curing the fish are concerned, than it was 50 years ago.

While a small proportion of the white men are excellent fishermen of the type required for hand-line fishing from dories, the majority of them are ordinary beach combers picked up on the water fronts of San Francisco and Seattle, or men of very little acquaintance with the sea even, let alone any fishing knowledge. The reason for this is that the salmon and halibut fisheries offer more congenial employment to the more intelligent and progressive of the fishermen. At the end of the salmon season in Alaska quite a few of the better class go to the shore stations and work there until the opening of the salmon season the following spring, when they take up the salmon work once more.

The natives generally are among the best of the station fishermen, as usually they are well acquainted with the locations of the many isolated spots that while rich in cod yet sometimes cover but a few feet or yards in extent and are difficult to find unless certain landmarks are well fixed in the mind. They are persistent and skillful fishermen and generally are among the high-line fishermen unless handicapped through age, disease, or bodily infirmity. They are apt to quit when the whim seizes them, but the author's experience with cod fishermen generally is that both whites and natives are apt to quit on very slight or no provocation at all, the desire for a change of scene at frequent intervals seeming, in their eyes at least, to be one of the essentials of the industry.

VESSELS AND BOATS

Fishing vessels.—Unlike the vessels used in the New England fisheries, there is no distinctive type employed on the Pacific cod fishery. Not a single vessel now used exclusively in fishing was built especially for that purpose. All of them were at one time brigs, barks, barkentines, or schooners employed in the carrying trade of the Pacific and were purchased for use in the fishery after they had attained varying ages. As the schooner rig has proved the most economical, the vessels have been altered gradually, until all are now of this rig. They vary in length from 102 feet 6 inches to 156 feet, and the net tonnage ranges from 138 to 464.

In Alaska a different type of vessel has been evolved. As the companies owning several stations frequently desired to transport goods and fish from station to station, small sailing vessels were employed in the early days. These had a large cargo capacity and were vessels that previously had been used in California waters for various purposes. As the trips made by these vessels necessarily were uncertain, owing to their dependence upon sails, it was soon seen that power vessels would be more profitable, and about 20 years ago the first vessels of this type were sent up under sail. In order to make them suitable for navigation under the trying conditions that prevail in this section of Alaska, they were greatly altered, but even then they proved far from satisfactory.

In 1912 the Union Fish Co., of San Francisco, had built on Puget Sound the first power vessel to be devoted exclusively to the codfish industry. It was a schooner-rigged vessel and was named the *Union Jack*. The vessel was 85 feet long, 18 feet beam, and had a net

tonnage of 39 tons. She was fitted with an 80-horsepower gasoline engine. As the owners had in view using this vessel during part of the year in fishing also, they tried to adapt her for both purposes, with the result that she proved somewhat unsatisfactory for either and was sold in 1913.

In 1914 the same company built another power vessel, the *Pirate*, to replace her. She is a two-masted schooner with knockabout rig and has a length over all of 64 feet 6 inches and a breadth of 21 feet.

FIG. 7.—Union Fish Co.'s schooner *Pirate*, Alaska station, fishing and working boat

The hold is 6 feet 10 inches deep and 23 feet long, which provides a carrying capacity of 100 tons. The after cabin has accommodations for the captain and two men. The galley and mess room also are located here. The forecastle provides sleeping quarters for six men. The engine room is just forward of the pilot house, from which the main engine is controlled, thus permitting the captain to operate the engine as well as the vessel. The propelling machinery consists of an 80-horsepower engine, while a 9-horsepower windlass is used for handling cargo. It is the company's purpose to use this vessel in fishing during the summer months and in freighting in local waters the rest of the year.

In 1917 the Alaska Codfish Co. built, and in 1918 sent north, two station tenders known, respectively, as *Alasco* (23 net tons) and *Alasco No. 2* (5 net tons). The first is 59.7 feet in length and is equipped with an 80-horsepower Union engine; while the latter is 43 feet in length and is equipped with a 40-horsepower Union engine.

As these proved to be very satisfactory, the company in 1919 built and sent north the *Alasco No. 3* (8 net tons), a vessel 55 feet in length and equipped with a 40-horsepower Enterprise gas engine. In 1920 still another, the *Alasco IV*, was built and sent north.

Transporting vessels.—For a number of years the companies operating shore stations in Alaska have been utilizing in fishing vessels of the same type and size as those used in taking cargoes of supplies north to the stations and in bringing back the fish caught by the station fishermen. Frequently the regular fishing vessels would be, and still are, sent north on this work during the winter season. As stormy weather, with plenty of fog, is the rule in the North Pacific Ocean, many of these vessels have met with an untimely end on the inhospitable shores in this region.

In 1913 the Union Fish Co., of San Francisco, had built a power schooner for this work. This vessel, which was named the *Golden State*, has a length of 145 feet, a breadth of 32 feet, and a depth of 11 feet 6 inches, and in addition to her engines is fully rigged as a three-masted, baldheaded schooner. She has a carrying capacity of more than 500 tons.

The propelling machinery consists of a 150-horsepower, 4-cylinder, distillate engine. It is connected with a two-bladed propeller by means of a disk clutch and spur-gear type of reverse. The two-bladed propeller is used in order that the blades may be placed in a vertical position when the sails are being used, and in this way the drag of an idle propeller is avoided to a large extent. The engine is so equipped that it can be handled at slow speed with ease.

The vessel has also a complete electric lighting plant, with dynamo and two sets of bilge pumps and a force or fire pump, all run off a countershaft, which is in turn run either from the main engine or when that is not running is driven by a 4-horsepower, single-cylinder engine situated in the engine room. Besides the quarters for its crew of 8 men, the vessel has cabin accommodations for 10 passengers.

Boats.—A considerable proportion of the dories in use with the fishing vessels and at the shore stations in Alaska were manufactured in New England and brought to this coast overland. Now a few of the coast boat builders are manufacturing them after the eastern model. The hand-line dories usually are 14 feet long, bottom measurement. Occasionally trawl lines are employed, in which event larger dories must be used in order to accommodate the additional man needed and the extra amount of gear required. These large dories are usually 15 feet in length on the bottom.

A few years ago one of the companies began to use line trawls at its shore station and employed round-bottom sailboats of the well-known Columbia River type in working them. The trawling experiment soon was abandoned and the boats were either sold or put to other uses.

During the season of 1914 the schooner *Fortuna* took north with her 12 portable engines suitable for attachment to the regular dories.

These were sold to the fishermen and were to be paid for out of the season's catch. The use of these engines did not prove satisfactory for a number of reasons, viz: The men generally knew nothing about their operation and care and grossly neglected them; the weight of the motor cut down the number of fish the dory could carry; while in rough weather, with the motor going and a load of fish aboard, the dory would ship heavy seas.

In recent years small gasoline launches have become a factor in the Alaska station fishing. Some of these are dories, some Columbia River type boats, while others are of nondescript types. Gasoline engines ranging from 2 to 12 horsepower have been installed in them. The chief disadvantage in the use of these in early days was that the regular hand-line fishermen operating from dories refused generally to permit the operators of these power boats to join with them in dressing the catch, and as a result they had to have a separate dress house, and unless there were enough of them to form a regular dress gang they found the business of dressing the fish rather laborious. As the number of power-boat fishermen increased at the various stations, however, this disadvantage was obviated. The companies also aided by concentrating the power fishermen at certain convenient stations. Two or more men generally go in the power boats, and as they are enabled to go with perfect safety to the outer and less-worked banks, their daily catch is much larger proportionately than that of the regular hand liners. The use of power also gives them a considerable advantage over the regular dory men, as they can go out in weather that would compel the sail and row dories to remain in port, and can go much farther away from the station and be sure of being able to get back.

The number of these boats is increasing yearly, and it is to be hoped that they will continue to increase, as the owners of them are among the most industrious of the fishermen—men who do not waste all they make in riotous living, as is the custom with the majority of fishermen. The larger companies never have encouraged the use of power boats, as they feared that in time the men operating them would become too independent and eventually become station owners themselves.

Nearly every hand-line fisherman carries a sail in his dory. The mainsail usually is of the leg-of-mutton type. Some have a jib, while a few also use a staysail. The sails generally are made of sheeting, which is much lighter than canvas. Fishermen are expected to furnish their own sails, together with the necessary mast and boom. For a number of years the companies provided these articles, but so many of the men failed to return them when paid off that the practice had to be abandoned.

LAY OF THE CREW

The methods followed in handling the catch and the lay of the crew are radically different from those on the Atlantic cod vessels. On eastern vessels the men catch and dress the fish and divide their share of the proceeds equally. On Pacific vessels the fishermen have nothing to do with dressing the fish, this being done by one or two dress gangs (the number depending upon the size of the vessel), the members of which are paid monthly wages, which begin the

moment the men are signed on and cease when the vessel returns to her home port. The fishermen are paid a certain sum per thousand fish.

In 1924 the fishermen on vessels operating from Puget Sound sailed under the following lay: Those catching under 7,000 fish received 1½ cents per pound; those catching between 7,000 and 9,000 fish, 1⅝ cents per pound; those catching over 9,000 fish, 1¾ cents per pound. The mate received one-fourth cent per pound more than the regular fishermen, while the second mate received three-eighths cent per pound more. Fish 28 inches or more in length are count fish; all under 28 inches in length count two for one. All fish must be bled by having their throats cut as soon as caught.

Under this arrangement the fishermen devote their entire working time to fishing, returning to the vessel only when a dory load has been obtained. In this way some of the fishermen will catch several hundred fish a day when good weather prevails. As hand-lining is employed almost universally, but one man goes in a dory.

A dress gang is composed of a splitter, header, throater, gutter, salter, a man to remove the black skin, and from one to two others, called "idlers," who pew the fish as may be needed. When two gangs are operating, some of the idlers do double duty and thus reduce the total number in the dress gangs. All members of the dress gang, and the cook, are encouraged to fish over the rail of the vessel, when not otherwise engaged, and for all fish so caught they are paid the same sum per thousand as the majority of the fishermen receive.

The owners of the vessels furnish all provisions, fishing gear, boats, and the bait taken along from the home port, the members of the crew not being required to furnish anything besides clothing and bedding.

The captains of Puget Sound cod vessels receive as their lay a certain sum per ton for the fish brought home. On the San Francisco vessels the captains generally are engaged by the year and are paid a salary. The arrangement of the owners with the captain is a private one and varies much, depending largely upon the reputation of the captain.

The following represent the average monthly union wages paid the various members of the dress gangs: First salter, $135 to $150; second salter, $90; head splitter, $125 to $175; second splitter, $90; header, $45; throater, $40; idlers, $30 to $40; salt passer, $40; cook, $150; cook's helper, $40 to $45; and donkeyman, $40. One Puget Sound vessel owner paid the head splitters an amount equivalent to that paid a fisherman bringing in 10,000 fish.

The great increase in recent years in the returns received by the more important members of the crew is well exemplified when it is stated that in 1895 fishermen received $25 per thousand fish; one salter, $65 per month; one splitter, $60; one cook, $55; four men to throat, head, and do the other dress work, $25 each per month.

The high-line fisherman of the 1925 fleet was Dan McEachern, of the schooner *Chas. R. Wilson*, who is credited with 20,070 fish, undoubtedly a record catch with hand lines for either the Pacific or Atlantic banks.

The lay on the local power vessels used in Alaska, which landed their catches at the shore stations there and to which they have been credited, is as follows: For dressed fish, 10,000 and over, $1 per hundredweight; for dressed fish, less than 10,000, 95 cents per hundredweight. At the stations the dory fishermen were paid 45 cents per hundredweight for whole round fish, while the splitters received 5 cents per hundredweight additional.

During the season of 1915 hand lines were used exclusively in fishing, but long lines, gill nets, and beam trawls have been used occasionally.

The hand lines are of special hard laid No. 72 untarred cotton seine twine. These are 7-pound cotton lines; that is, one dozen 25-fathom lines weigh 7 pounds. Two to three of these lines are required to make one single fishing line, and each fisherman operates at least two fishing lines. Each line is generally fitted with a spreader, to which are attached two snoods. The hooks in general use are the No. 8, eyed, japanned "Gravitation" and the No. 7 "Baylies." Most of the fishermen file down the long sharp point on the former hook. The leads weigh 5 pounds. No. 2 swivels are used in attaching the snoods.

Unlike his east-coast brother, the Pacific cod fisherman worries but little about bait. Before sailing, enough herring are taken along for a couple of days' baiting, but the fisherman usually gets enough shack fish the first day to furnish him with plenty of bait for the next day, and so on throughout the season. Sculpins, halibut, porgies, octopus, salmon, etc., form the principal sources of bait supply. In baiting the hooks the fish are slivered, steaks being cut from each side of the backbone. These are cut into three-cornered or square pieces, and are strung upon the hooks to the number of six to eight. Octopus is the favorite bait, a boatload of fish frequently being secured with pieces cut from one tentacle of this mollusk. Although clams are abundant in Alaska, the fishermen rarely ever bother to dig them for bait.

SEASON, METHODS, ETC.

The vessels generally leave their home ports between the middle of March and the middle of April, and arrive in the neighborhood of the Shumagin Islands, in the North Pacific, in from two to three weeks after sailing. The Shumagin Islands are about 1,553 nautical miles from Seattle and about 1,903 nautical miles from San Francisco.

As there is floating ice on the cod banks in Bering Sea at this time, most of the vessels fish off the southern side of Unimak Island. The early part of May some of the vessels move over to the southeast point of Sannak Island and spend the greater part of the season on the Sannak Bank, but the majority of them go into Bering Sea, where fishing usually is begun in Dublin Bay and on Slime Bank. Toward the latter part of June the Bering Sea fleet begins to work north onto Baird Bank, moving along by Port Moller and up as far as the mouth of the Ugashik River and occasionally, but not often, up into Bristol Bay proper.

The vessels that fish exclusively in the North Pacific Ocean sometimes spend the early part of the season on Shumagin Bank, working

later on the Sannak Bank. A few start fishing at Cape Pankof, off the southern side of Unimak Island, as stated above, and work thence onto Sannak Bank, where they finish the season.

One great advantage the Pacific fisherman has over his Atlantic brother is that he does not lose any time because of enemies of the cod driving them off the banks, as is the case in the east, where vessels are sometimes tied up for weeks on account of dogfish. While the dogfish is to be found in Alaska waters, it is not sufficiently abundant to become a pest.

All Pacific codfishing is done in the daytime. Owing to the high latitude of the banks and the fact that the vessel fishing season is the summer time, when the hours of daylight are most numerous, the hours of darkness rarely exceed four and are even less during June and July.

FIG. 8.—A cod fisherman's home on Sannak Island, Alaska

Early in the morning the dories are put over the sides of the vessel, which has been anchored in a favorable spot. Each dory is equipped with the necessary fishing lines, a small sail, a water beaker, a windlass for hauling in the anchor, a 10 or 14 pound anchor, a small keg buoy, a knife for cutting bait and bleeding the fish, a gaff for handling the large fish and with which most of the fishermen stun or kill the fish by striking it on the head with the handle.

But one man goes in a dory, and each rows away in search of a good place to fish. The direction in which they row is to a great extent governed by the tide and force of the wind, the idea being to utilize the wind and tide to help in getting back to the ship when the full dory would make rowing laborious. As the fish at times seem to be quite numerous in small, isolated areas, considerable luck enters

into the fishing. When one of the fishermen is perceived to be successful his mates are apt to try their luck on the same spot. The men return to the vessel about noon, or sooner if a dory load has been obtained. After obtaining their dinner they go out again, and sometimes a trip is made after supper. Each man's catch is counted as he pews the fish inboard upon his return to the vessel.

During the last few seasons some of the companies that operate both fishing vessels and shore stations have anchored certain of the former at favorable spots in the North Pacific, and, concentrating a fleet of local power and sail dories with the vessel as a focus, have used her as a salting station. As soon as the vessel wets all her salt she sails for the home port, while the local fishermen return to their former shore station and resume fishing there.

While the fishermen are out on their first trip of the day the members of the dress gang usually fish over the rail of the vessel, and some of them do this whenever they have a few spare moments. These men are paid a fixed sum (usually an average of the prices paid the fishermen) for all fish so caught, which is in addition to their regular wages.

Trawl or long lines.—But little trawling or long lining ever has been done by the vessels fishing on the Alaska banks, and none by those fishing on the Okhotsk banks. In 1888 the schooner *Arago*, belonging to Lynde & Hough, of San Francisco, employed long lines on the Bering Sea banks, but the fishermen claimed that the fleas (amphipod crustaceans) devoured the cod or injured them so badly that the use of such lines had to be abandoned.

But few efforts along this line were made by the vessels of the fleet until in 1913, when the schooner *Vega* and the power schooner *Union Jack*, belonging to the Union Fish Co., of San Francisco, used long lines for a considerable part of the season. On the *Vega*, which fished on the outer banks off the Shumagin Islands, the ground line of the trawl was of 20-pound tarred cotton. The gangings, which were about 3 feet in length and set about 6 feet apart, were of 6-pound tarred cotton. The hooks used were of the 10/O japanned Limerick brand. The lines were coiled in tubs made by sawing barrels into equal halves. Each dory crew was expected to have rigged up 42 long lines of 50 fathoms each, but under ordinary conditions would rarely ever have in the water at one time more than 14, one-half of the balance being baited and ready for use, while the rest were held in reserve in case of emergencies.

Around the edges of the top of the cabin of the vessel were nailed boards. When ready for the first baiting the fishermen dumped the bait onto the top of the cabin and then stood in the gangways and cut up the bait on the boards, and as fast as the hooks were baited the line was carefully coiled in a tub with the baited hooks in the center of the coil. Only one piece of bait, and that not a large one, is put on a hook.

The buoy line used was of 6-thread manila. At the surface the ends were marked by 10-gallon buoy kegs, painted red, attached to the buoy line by swivels similar to those used for this purpose by the halibut fishermen. On rough bottom the ground line was buoyed up by glass balls attached at intervals. Twelve or fourteen pound anchors were attached to each end of the trawl.

In the bow of each dory was fixed a roller that worked on a pivot, over which the ground line was hauled. There are always two men in a dory when a vessel is long-lining, one man to haul the line and shake off the fish, which he does by a dexterous twist of the wrist, while the second man baits the hooks and coils the gear in the tubs again. The men usually brought the line in when returning with the catch, but sometimes when the weather looked propitious the line would be underrun, the fish removed and new bait substituted, and allowed to fish again while the men took their catch aboard. Sometimes the lines would be set out late in the evening and allowed to remain down until the men went out early in the morning.

The long lines were handled in the same manner as on the Atlantic coast. In setting a line, two men go in a dory, one to throw the line and the other to row the boat. Having arrived at the place where the set is to be made, a buoy is fastened to one end of the buoy line and thrown over the side. The buoy line is then allowed to run out until the end is reached, when it, together with the upper end of the long line, is bent to the ring of the anchor. The anchor is then lowered over the side, and the line thrown from the tub until the lower end is reached; it is then fastened to the upper end of the second tub of line and so on until all of the tubs—two, three or more—have been set. The last end of the long line, together with the second buoy line, is bent to an anchor and thrown over the side, care being taken to prevent the buoy line from fouling with hooks of the long line as it is thrown out. To the free end of the buoy line is attached the second buoy. The method of "underrunning" a long line permits the removal of the fish from the hooks and rebaiting them in a single operation, thus saving a considerable amount of labor. "Underrunning" is sometimes performed on ground where fish are plentiful and when the weather is suitable for such operation. A long line intended to be "underrun" is set in the usual manner, with slight variation. A becket is made in the buoy line about 10 or 12 fathoms below the buoy. In the becket is bent a small line, which reaches to the bottom, and to the bottom end of this line is fastened a stone weighing about 6 pounds. The ground line of the trawl, instead of being fastened to the ring of the anchor is attached to the small line close to the stone. When thus set there is sufficient distance between the anchor on the buoy line and the stone on the small line to permit of the line being lifted without disturbing the anchor. In hauling, the buoy line is pulled up until the small line running to the anchor is reached, the stone is hauled up, and the end of the ground line is passed over the dory. One man unhooks the fish and the other baits the hooks. In this way the dory passes under the entire length of the line and the fish taken from it and the hooks baited in a single operation. The object of operating lines in the manner described is to keep them in one position during the time when fish are plentiful.

On sandy bottom the fish sometimes are eaten by sand fleas, and to prevent this glass balls attached to the ground line at frequent intervals keep the fish clear of the bottom, where the fleas are most numerous.

While the use of long lines by the *Vega's* crew was found to be quite successful, so far as catching fish was concerned, the difficulty of pairing off congenial fishermen and the finding of men

who were familiar with the operation of long lines proved too much of a handicap, and in the latter part of the season hand-lining was resorted to.

A very important advantage in the use of long lines is that the men will fish with them in much deeper water than they will with hand lines. The largest and best cod are found in the deeper waters, and it is from these that the owners would like to get the bulk of the catch; but when hand-lining the men either refuse openly to work in the deeper waters or else secretly neglect the fishing and bring in but few fish when the captain insists upon anchoring on the deeper portions of the banks.

The experience of the *Union Jack* in long-lining is described under the section devoted to shore stations.

For some years long lines were in general use by the station fishermen but were given up eventually because large quantities of gear and fish were lost because the men were unable to get out to the banks in stormy weather and because the fishing required more skill than was possessed by most of the green hands available.

As the ground upon which they could fish was somewhat limited for long lines, the fishermen first agreed among themselves as to how the ground should be apportioned. In setting the long line two men went in a dory, but in fishing it the work was done by one man, as the line was allowed to remain on the ground for at least a week and sometimes longer. Before setting the line the bottom was sounded carefully with a hand line in order to be sure of getting the right spot for fishing. An anchor and line with buoy attached was dropped overboard first, then the ground line was paid out in the direction agreed upon with the other fishermen, after which the other anchor and buoy line were set. The ground line was left sufficiently slack so that it could be hauled to the surface without disturbing the anchor, but not slack enough to permit of the line snarling. In fishing it, the fisherman went to the leeward buoy and hauled up the bight of the line until it lay across the bow of his dory; then, by hauling on this line they pulled the dory against the tide in the direction of the other anchor, the line passing across the bow of the dory so that the hooks that came in on one side were freed from fish, rebaited, and thrown over on the other side of the dory until the line was completely underrun or the dory filled with fish, when the line was thrown off again and the trawl left set as before. The ground line of these long lines was 9-thread manila, while the buoy lines were of 6-thread manila, commonly known as "dory rode." The gangings were of 6-pound lines, i. e., 12 lines of 25 fathoms each weighed 6 pounds. They were 22 inches in length and were attached to the ground line at intervals of 3 feet. The number of hooks used varied from 500 to more than 1,000, according to the number of tubs set.

During the season of 1913 the small power schooner *Union Jack*, with headquarters at the Pirate Cove station of the Union Fish Co., engaged in long-lining on the inshore banks of the Shumagin Islands, mainly in West Nagai Strait.

As it was the intention later in the season to use the *Union Jack* in gill-net fishing for cod from the deck of the vessel by means of a net lifter (described elsewhere in this report), the machine was

placed on board at the beginning of the season with the hope that it could be used in hauling long lines.

The process of tarring seemed to weaken the lines. Untarred lines were used for renewals and were found to be much stronger and more durable.

Both 32 and 20 pound cotton tarred lines were used for ground line, while the gangings were of 6-pound tarred lines. Experiment developed the fact that 20-pound lines were amply heavy and strong enough for the work, and that untarred cotton lines were more durable and stronger than the tarred lines used, the tarring seeming to weaken the line. In the last experiments the gangings were each

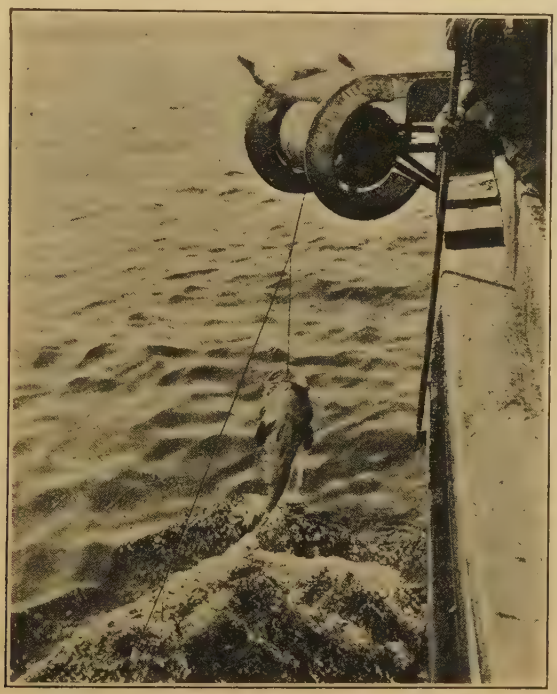

FIG. 9.—Cod trawl line hauled by means of net lifter on deck of vessels

about 5 feet long and were attached about 6 feet apart, this being necessary because of the high freeboard of the vessel.

Only a couple of skates of gear were rigged for experimental use with the machine. After being baited these skates were coiled on movable plank platforms about 5 feet long by 2½ feet wide. Placing one of these at the stern of the vessel an experienced man could pay out the line by means of two short sticks (a method followed by the Norwegians), in order to prevent the possibility of the hooks catching in a man's flesh or clothing, as fast as the vessel could steam. An anchor and buoy were at each end of the long line, which was set with the tide.

After the net had been down a couple of hours the vessel came up to the leeward buoy in order to haul against the tide. The buoy was

first hauled in by hand. The buoy line was then slipped under the fingers of the net lifter, the engine started, and the line reeled in at full speed. When the anchor appeared the machine was stopped, the anchor lifted inboard by hand, and the end of the line placed under the fingers and the machine started again. Of the crew one man ran the engine; one stood along the rail just aft of the machine with a long-handled gaff, ready to gaff cod that might break loose from the hooks; another stood just back of the machine itself and shook as many of the fish off the hooks as possible; while two men removed and killed the balance of the fish, coiled down the line as it came from the machine, and attended to other work.

The vessel used for the experiment was not well suited to the purpose because of its slow response to the rudder (a serious handicap, as it is necessary for the vessel to be kept well over the line at all times and thus relieve it as much as possible from strain) and the high freeboard, owing to which a number of fish were lost, because their weight caused them to break loose while traversing this long distance. Despite this, however, the experiment indicated clearly the value of the machine in hauling long lines from the deck of a suitable vessel.

As experienced fishermen were not available for carrying on power long-lining from the deck of the vessel, the crew trawled by hand from dories during the rest of the season and met with good success. In operating from dories the long lines were rigged in the same manner as on board the *Vega*.

Gill netting.—In the summer of 1913 the author conducted some experiments in gill netting for cod in the waters adjacent to Pirate Cove, in the Shumagin Islands, Alaska. No originality is claimed for this method, as for a number of years gill netting for cod has been carried on in Ipswich Bay, Mass., and at a few other places along the New England coast, while about 13 years ago some of the Great Lakes fishermen visited Gloucester with their steam tugs and engaged in gill netting for cod, haddock, and pollock on a large scale. For a number of years the Great Lakes fishermen have carried on important gill-net fisheries for lake herring, trout, and whitefish. Steam tugs have been employed almost universally, and from 5 to 10 miles of netting were set at one time. The use of this immense quantity of netting was made feasible by the employment of a patented power device, known as a net lifter, for hauling in the nets.

The net lifter is a circular machine fitted along the outer rim with a number of fingers. The mechanism that operates these fingers moves on tracks and is so arranged that the fingers take hold as they come opposite the rail of the vessel and let go when they have completed about two-thirds of one complete revolution from the point where they first gripped. By this means the net is grasped by the fingers as it comes aboard, and after being carried about two-thirds of the way around is released and allowed to drop on the deck. A framework extends from the lifter outboard and at the outer end is a roller, while a sheet-iron trough for the passage of the net and fish runs from the roller to and partly around the machine and rests upon the framework. The machine is operated either by a small gasoline engine or directly from the main engine.

The net lifter generally is set on the port side, forward of the fore rigging, although it will work about as well when set on the starboard side or when close aft of the fore rigging.

At my instance the Union Fish Co., of San Francisco, with its usual progressiveness, purchased the necessary number of gill nets for an experiment on a moderate scale, a net lifter, and a 4-horsepower Imperial engine to operate it.

The gill nets were 125 yards long each and were made of 12/3 cord linen. A specially made line was used for head, foot, and side lines. The nets were of 7½-inch stretch mesh and were 15 meshes deep. The floats, which were made of white cedar, were 2 inches by 5 inches

FIG. 10.—Machine used for hauling in cod trawls

and had been soaked a number of times in boiling linseed oil in order to make them waterproof. Fifty of these were used to the net and were hung from the cork line and not strung on. The leads, which were 3½ inches long with a diameter of thirteen-sixteenths inch, weighed 7 ounces each, were made to close on the line and not to be strung on and were set opposite the floats.

As the nets were primarily for use during the winter season, when the spawning cod are on the inshore banks, the work carried on during the summer was merely preliminary and mainly for the purpose of accustoming the men to use the nets.

Boxes with flaring tops (so that they would nest) were constructed, and in these the nets were stowed, with the lead line at one end and the cork line at the other; these boxes held about four nets each.

When ready to set the net the boxes were arranged on the after deck, and as the vessel steamed along the anchor, buoy, and buoy line were thrown overboard, and the nets were then paid out by two men, one handling the cork line and the other the lead line. Another man bent on a new net when the previous one had almost run out. After all had been set they were held and marked by another anchor and buoy. The nets were set across the tide and as nearly as possible in the shape of a crescent. While most of them were set on the bottom, a few were elevated slightly by means of glass floats. Almost invariably, however, the nets raised above the bottom caught no fish.

In hauling in the net, a great deal depends upon the captain. In order not to put too much strain upon the nets or the machine, the vessel should be kept as nearly as possible over the former, and in certain kinds of weather and at certain stages of the tides this requires careful maneuvering on the part of the navigator.

The nets were set out in the evening and were taken up at as early an hour in the morning as possible, as the flesh of the cod will discolor if the fish are not bled soon after they die. Steaming up to the first buoy, this was taken aboard. The buoy rope was then slipped under a couple of the raised fingers on the net lifter and the engine started. As soon as the fingers gripped the rope, no further handling was necessary except to coil it aft of the machine as it was reeled in at full speed. When the anchor appeared it was lifted aboard by hand and the head and foot lines of the net were then joined together, thus doubling the net over, and placed under the fingers and the engine started again. But few stops were necessary, and then only when a large skate was found in the net, as the cod, halibut, and other fish passed along the trough around the machine without any trouble. A man with a gaff was stationed just aft of the machine, and his duty was to gaff all fish insufficiently meshed and apt to fall out of the net as it was lifted from the water. Other men received the net from the machine, shook out the fish, and stowed the former back in the net boxes.

An odd feature of the experiment was the comparatively large number of halibut caught in the few nets set one day. In one haul with 10 nets, 180 cod and 60 halibut were taken, the halibut ranging in weight from 5 to 30 pounds. No halibut were taken in the other trials with gill nets, while none at all were taken in the course of the trials with long lines.

Ashore, the nets were run onto large reels, and here they were dried and mended with a minimum of expense. The reels were so nicely adjusted that a child could turn one, even when laden with four or five nets.

When in regular use, it is the intention to have the nets divided into three sets. One of these will be in the water, one will be aboard the vessel, while the other will be ashore. All mending and drying of nets will be done ashore, the fishermen having nothing to do with this part of the work.

This experiment was soon abandoned, solely because of the difficulty experienced in persuading the fishermen to take it up and handle it properly.

While the machine will work upon the codfish banks profitably, either with gill nets or line trawl, it is probable that in the near

future the machine will be used principally in the salmon and halibut fisheries of Alaska. With one of these machines placed upon the deck of a cannery tender, a crew of not more than five or six men could set out and haul in from 5 to 10 miles of gill netting in a working day, and do this in weather too rough for a Columbia River boat. The gill nets at present in use would have to be reduced in depth about one-half in order to work in the machine, and the work could then be carried on much more cheaply than is the case under present conditions, provided no legal obstacles were placed in the

FIG. 11.—Cod gill nets on drying reel

way. With the use of a large power vessel gill netting could be carried on in the open bay or sea if the owners so desired.

If the lifter were used in the halibut fisheries, all the long-line fishing could be done from the deck of the vessel, and dories could be discarded. Fishing could be carried on with it at all times except during the more violent storms. Since the above was written a similar device for hauling in long lines has come into use on our halibut vessels.

Trawl nets.—In 1919 and 1920 tentative experiments were undertaken to test trawl nets on the cod banks, but these were unsuccessful at the time because of the rocky patches on the banks and because the local fishermen are either passively or actively against the introduc-

tion of any new and improved methods and would not give the nets a fair trial.

DRESSING THE FISH

As soon as enough fish accumulate on the deck the dress gang begins its work. The "throater" seizes the fish by the head with his left hand, places the back on the edge of a table or tub, and by means of a short knife with pointed end makes a cut in each side of the throat just behind the gills (the front of the throat has previously been cut by the fisherman in order to bleed the fish), and another slit is made from the belly to the vent. The "header" then receives the fish and presses it backward across the edge of the table or tub, which results in breaking off the head at the first vertebra. With his left hand he then opens the belly and tears out the viscera. The fish is then passed on to the "splitter," the most important member of the gang, who places the back of the fish against a cleat on a board, and by means of a short, heavy knife, rounded at the end and with the blade slightly curved flatwise, continues the split down the belly to near the end of the tail, taking care to keep near the backbone. At about three-fifths of the distance from the neck to the tail the backbone is cut across and is loosened, so that the operator can catch the end in his fingers. Grasping this with his left hand he cuts under it toward the head of the fish and separates the upper part of the backbone from the fish. In this operation the knife blade is kept close to the backbone to prevent loss of flesh, and a good splitter will drive the knife no deeper than is absolutely necessary, as otherwise the thick flesh at the back would be cut almost in two, thus spoiling the fish for middles. The sounds are not saved, and only rarely are the livers saved on the vessels.

Recently that wonderful machine, the "iron chink," used in the salmon canneries to cut off the head and tail of a salmon, remove the fins, split the fish down the belly, and remove the entrails, and then slime or clean the fish, was adapted for use in dressing and cleaning codfish. In addition to the operations noted above the machine removes the backbone and does the work better than the splitter can do it by hand, and, of course, at vastly greater speed. Several of these machines have been installed in plants on the Atlantic coast, where they have proved eminently satisfactory.

The fish are then passed to the "black skinner," who, with an old glove or a piece of bagging, rubs off the nape skins or membrane covering the napes, also any blood spots, and then drops the fish into a tub of salt water. Here lesser members of the gang, who are called "idlers," souse the fish until they are thoroughly clean, when they are removed and passed through a chute into the hold, where the "salters" receive them.

The salters lay the fish on their backs, with napes and tails alternating, with the exception of the top layer, which is turned back up. A liberal sprinkling of salt is thrown over each layer, an especially heavy portion being put on where the fish come in contact with partitions or the sides of the vessel. The kenches are about 4 feet deep and extend from side to side of the vessel and the full height of the hold. The first kench usually is started in the forward part of the hold, and the salter works toward the after part. As the

kenches settle additional fish are placed on top to keep the compartment full.

A great deal depends upon the thoroughness with which the work of salting is done, as it is important that every part of the fish shall receive a share. If the salting is well done, it is not often that the fish need to be rekenched; but if the salt is used too sparingly or is unevenly applied, souring may start, which necessitates moving whole kenches and resalting. Sometimes the effort is made on the Atlantic coast to salt a little slack in order to make the fish heavy on reaching port, with the result that the whole catch may be lost. Slack salting, owing to the length of the trips and the fact that the fishermen would not benefit because of the increased weight of the fish, is rarely ever attempted on this coast. As the fish lose their moisture from salting, it runs to the bottom of the hold and is pumped out. About 21 sacks of salt (weighing 100 pounds each) are used to 1,000 fish when in kench.

Soured fish have a peculiar odor, not very different from that of sauerkraut. Those accustomed to handling the fish become expert in recognizing this trouble and can pick out the infected fish instantly.

Much is said by the fishermen about the practice of dressing the cod on the banks and throwing the gurry overboard, and it is claimed that the gurry decays on the bottom and the taint drives the fish away. As sand fleas (amphipod custaceans) are very abundant on the inshore and offshore banks, these scavengers, together with sculpins and other bottom feeders, speedily remove every particle of edible meat from the gurry, thus preventing any possibility that the water may become polluted. Should a couple of days' stormy weather prevent fishing, the sand fleas will be found to have almost caught up with the accumulation of gurry, while at the seasonal stations, the usual large pile of gurry has been reduced to a comparatively small heap of bone absolutely cleaned of all flesh a month after the season closes.

SHORE-STATION METHODS

The methods followed by the shore stations are somewhat different from those in use on board the vessels.

The shore fishermen usually rise between 3 and 4 a. m. in summer and between 4 and 5 a. m. in winter. After breakfast the men row out to the near-by banks in their dories. From 9 to 12 they straggle in with varying numbers of cod, depending somewhat upon luck but mainly upon how well the fisherman knows the "good spots" and the persistency with which he has fished. The dories in use hold from 180 to 220 fish, depending upon their size. A dory containing 220 fish could be handled only in calm or fairly calm weather, as it would be so low in the water as to ship a sea at every lurch in rough weather.

Upon reaching the station the fish are pewed from the dory into a box fastened to the side of the wharf midway between the top and low water. From here the fish are pewed onto the dress-house floor (the dress house is either at the end of the wharf or midway of the same), while the agent or his representative keeps the tally as the fish are thrown upon the floor.

In the bunk house is hung a board ruled so as to show the name of each fisherman and the amount of his catch from day to day. As soon as all the boats are in the agent notes on this board the catch of each man for that day, which gives each man an opportunity to know just how he stands and to have any necessary corrections made.

Dinner is at 12 o'clock, and shortly after the fishermen gather at the dress house and, dividing themselves into as many dress gangs as their numbers will permit, begin the work of dressing. No special dress gangs are employed at the stations, as the dressing is considered to be a part of the fisherman's regular work.

That portion of the dress gang in the dress house generally is composed of a "throater," "header," "splitter," a "black skinner," a man to go over the fish and remove adhering backbones, clots of

FIG. 12.—Landing the day's catch at the shore station

blood, portions of black skin, etc., left by those who previously had handled it, and a man to pew the fish into the throater's box. The duties of these men are about the same as on the vessels. Each dress gang is equipped with a box set up on legs and with a sloping grid-iron bottom, so that water, slime, etc., may pass out through the bottom. In this box the fish are placed with their heads toward the throater. Alongside and attached to the box is a table. The header stands at the end of the table next to the box, on the opposite side from the throater and splitter, and has in front of him a piece of iron fastened to the edge of the table, over which he breaks the backbone of the fish as they are passed to him. At the other end of the opposite side of the table stands the splitter. In the top of the table in front of him has been inserted a piece of wood about 15 inches long and about 10 inches wide. Into this has been driven a

sharpened nail, to which the fish are attached so that they may not slip away while he is splitting them. The board inset obviates the necessity of renewing the whole table top after the splitter has cut and chopped here for a short time.

Usually there are two or three gangs at a station, and in addition to the above there are usually two men who trundle the dressed fish in large wheelbarrows to the butt house, where two salters receive and salt them in the large tanks.

During the summer months the livers of the cod are saved and dumped into large casks just outside the dress house, this work being

FIG. 13.—Dories nested and dress gang finishing up the day's catch

done by the header. Here they are allowed to rot out. The oil gradually comes to the surface and at intervals is dipped out into barrels or drums. At present no attempt is made to prepare medicinal oil, although the Union Fish Co. had a plant for this purpose at the Pirate Cove station some years ago. As the healthy and diseased livers are used together, only oil suitable for use in the arts is rendered at present.

The offal passes through chutes into the water under the dress house, from whence it is either washed away, rots, or is devoured by gulls and sand fleas. At some stations the latter are so numerous that in a surprisingly short time the bones of the fish are polished clean.

The salting houses are long, low structures with but few windows, which leaves them usually in deep twilight. Generally they are arranged with two rows of square or round tanks, with a passage-way between them for the wheelbarrows to pass in and out. The large square tanks hold about 4,000 medium-sized fish, while the large round ones hold about 3,000. As a rule these tanks are made of redwood staves or planks held together with metal hoops or bolted together with iron bolts. At a few places small hogsheads are employed. These receptacles frequently are in use for years.

FIG. 14.—Loading codfish aboard the transporter by means of nets

Before the dressing begins each salter brings from the salt house about the number of bags of salt he expects to use. Usually this is figured on the basis of 17 sacks (holding 100 pounds each) to 1,000 fish. The quantity used varies, however, with the weather and the fatness of the fish.

The fish are placed carefully in the butts in layers, face or flesh side up. Salt is sprinkled over each layer, care being used to see that every part of the fish is covered. The layers are carried from 18 inches to 2 feet above the top of the butts so as to allow for the settling that will occur as the moisture is drawn from the fish. No pickle is necessary on these fish as they make their own. When the

fish have settled below the top of the butt, which they will do in a few days, several layers of new fish are added. In Alaska the pickle in the butts is kept at from 87° to 97°, salinometer test, the average being about 90°. As the climate in Alaska is nearly always cold and damp, there is but little danger of fish spoiling if ordinary care is used. Fish will keep indefinitely in strong pickle so long as they are covered with it. If kept for a long time the pickle must be replenished occasionally to repair the losses, particularly from leakage. At the stations the fish at the top of the butts are inspected every few days. When the pickle begins to weaken the top layer is turned back up and a few bags of salt laid on top. These press the fish down, and the salt in the bags dissolves much more slowly than if it were thrown loosely over the fish.

At a few stations where the salinometer is not used the agent uses a potato to determine when the pickle is strong enough. If the potato floats at the surface the pickle is strong enough for curing cod.

The pickle forms very rapidly in the early stages of the curing and the surplus is allowed to escape at intervals through a bunghole in the butt.

Care must be taken to see that the roof does not leak during heavy rains, as should fresh water drip into the butts the fish will become slimy.

Should the run vessel be delayed and a station become filled to its butt capacity, a space is cleared in the salt house and the fish taken from the first filled butts are kenched on the floor, a little salt being sprinkled between the layers and over the top. Every effort is made to hold them in the butts as long as practicable, as they retain their natural white color much better when in pickle, kenched fish usually acquiring a yellowish tinge.

When the station vessel arrives the pickle is allowed to run off the fish and they are pewed out into carts and wheeled along the dock to a point opposite the vessel's hatch, where they are dumped into a chute and pass thence into the hold. Here men receive and kench them in the same manner as on the fishing vessels, almost no salt being used, however, as the fish are already well cured and have a considerable quantity of salt adhering to them.

At stations where the vessels can not lie alongside the dock, owing to shoal water, the vessel is anchored in the bay or harbor and the fish are brought out to it in dories that are loaded from a chute rigged up at the outer end of the dock. When a dory is full it is rowed out alongside the vessel and the fish are pewed over the rail. As the vessel's rail is a considerable height from the surface of the water when she first begins loading, it is generally necessary to rig a stage about midway between the surface of the water and the top of the rail. The fish are then pewed onto this stage, whence one of the crew pews them over the rail onto the deck, and another man then pews them into the hold. This method is very expensive, as it requires a large number of men, is quite slow, and also injures the fish through excessive pewing.

In 1912 one company had square rope nets made similar to those used by cargo vessels in handling small packages. A small one is placed in the forward end of the dory and a larger one in the after end, space for the boatman to stand being left between the nets. The fish drop from the chute into these nets. When the dory arrives

alongside the vessel the cargo hook is lowered over the side. The four corners of the net have been drawn together at the top and these are slipped over the hook, the vessel's donkey engine started, the net with its contents lifted over the rail and lowered into the hold, where it is emptied by catching the hook in the meshes at the back of the net and starting the engine again. As the net comes up it is emptied, after which it is swung over the side and lowered into the dory, when the operation is repeated with the other net. By this method a vessel is loaded in about one-third the time previously required, while but few fish are lost alongside the vessel owing to carelessness in pewing. Another advantage is that it is not necessary to pew the fish after they are thrown into the carts.

There is a considerable loss of fish in passing them from the dock to the dory, especially in rough weather when the dory bobs up and down like a cork. The use of chutes with closed sides and built-in sections, so that they could be lengthened or shortened as the tide ebbed or flowed, would save a considerable part of the present wastage from this cause.

If the net method is not employed, the best way would be to have medium-sized scows for transporting the fish from the dock to the side of the vessel. With these the waste would be almost negligible, as they would be so much larger than the dories that practically no fish would be lost overboard while the scow was pitching and rolling in the swell alongside the dock; and owing to the greater weight and size of the scow the work of loading could be carried on in weather too rough for dories to work in.

WASTAGE IN THE INDUSTRY

There is much more waste in the Pacific fishery than in the Atlantic, due mainly to the different methods of arranging the fishing lay. In the Atlantic fishery every man has an interest in the catch and it is to his advantage to utilize every portion of the fish, thus increasing the total value of the fare, which means a larger share for himself in the final division. In the Pacific fishery the fishermen are paid a certain sum per thousand for fish running over a certain size and a smaller sum for fish under that size. On the vessels the fishermen have nothing to do with dressing the fish, which is done by a separate gang paid regular monthly wages. At the shore stations the fishermen dress their own fish and are paid a certain sum per thousand for all caught. As a result of this arrangement the Pacific crews resent doing more than merely catching and dressing the fish, and they even skimp the latter operation all they possibly can.

Livers and tongues.—As they receive no pecuniary benefit from the saving of livers and tongues, the fishermen naturally make no effort to do so unless compelled to by the owners. In dressing the fish at certain stations the header is expected to tear loose the liver and drop it into a bucket, which, when full, is dumped into the liver butt. Even at such stations, however, probably not one-fifth of the livers available are saved. At some stations and on certain vessels an extra boy is engaged whose business it is to cut out tongues, for which he is paid from $3.50 to $5 per barrel and his board.

Sounds.—Several times efforts have been made to cut out and save the sounds, but the men always have asked such a high price per hour for the work, and so few would be secured in an hour's time owing to the difficulty in cutting them loose and the general disinclination of the cutter to work, while their thinness made it necessary to cut out a large number in order to fill a barrel, that the cost of obtaining them was out of all proportion to the selling price.

Cod roe.—During the winter and spring the cod spawn in Alaska, and as large quantities are captured by the station fishermen at that

FIG. 15.—Native boy cutting out cod tongues

time cod roe is exceedingly abundant. The roe of the cod is an excellent food product, but except for a few served to the men in the mess houses no use is made of them. They could be preserved, either by pickling or freezing, and a possible market found for them in this country.

In the Atlantic fisheries large quantities are prepared as "rogue" and shipped to France, where it is used as bait in the sardine fisheries. In preparing "rogue" the roes should be soaked for some days in old brine and then packed in strong casks holding about 25 gallons each.

Heads and cheeks.—To many, a cod head, well cooked, is the choicest part of the fish, but unless one is at a shore station or aboard one of the vessels when fishing it is impossible to get one. If some one were to bring heads down to the coast States in brine doubtless he could build up quite a market for them. As nearly all of the nutriment is in the lower half of the head, a small band saw could be installed and the upper half of the head, which is bony and contains but little nutriment, cut off and thrown away and only the lower part, which contains the fleshy cheeks and the succulent tongue, saved. When glue and fertilizer plants are established at the stations, as will doubtless be done in the near future, the upper part of the head, which is rich in glue, could be used for this purpose.

Should it not be considered desirable to save the heads, the cheeks (a good-sized piece of choice flesh on each side of the head) could be cut out and preserved. Halibut cheeks, which are no more choice than cod cheeks, are always to be found in our larger coast fish markets.

Bones.—Fish bones are coming into quite general use by preparers of chicken food. These people grind up the fish bones, and, mixing them with other ingredients, obtain an excellent food for chickens. At present it does not pay to ship the bones, owing to their lightness as compared with their large bulk, but machines for grinding them could be introduced and the powder obtained shipped profitably.

Salt.—A large amount of salt is thrown away annually because of the belief amongst packers generally that salt once used in pickle, though not dissolved because of the excess employed, becomes exhausted. That this is not true can be demonstrated readily by dissolving it in water and testing it with a salinometer. While it might not be desirable to use it a second time in the salting tank, it could be washed and used in curing snappers and other fish that are to be marketed in a pickled condition.

LOSSES IN WEIGHT

There are but few data available on this coast showing the loss in weight in dressing and curing cod. The records of two typical vessels of the fleet for the years 1922 to 1925 show the following numbers of fish landed, their cured weight as landed at the home port, the average weight per cured fish, and the average dried weight and average round weight for the four years:

Year	Number of fish	Weight as landed, in pounds	Average weight as landed, in pounds
1922	324,440	1,409,875	4.345
1923	368,812	1,352,711	3.699
1924	408,778	1,580,771	3.898
1925	394,001	1,544,629	3.920
Average weight per fish as landed for the 4 years			3.965
Average round weight per fish for the 4 years			11.250

These fish had been dressed (head, entrails, and the greater part of the backbone removed) and salted in kenches in the holds for from two weeks to three months before being landed. All reports

available (and they are not very abundant) show a loss in weight in dressing of 45 to 55 per cent, while in curing before arrival at the home station the loss was about 17 per cent of the gross. In order to be conservative the loss in dressing has been placed at 50 per cent and the loss in kenching at 15 per cent of the gross, or 65 per cent altogether. The loss in drying on the flakes was about 5 per cent of the gross weight. This represents a total loss in weight from the round fish to the end of the flake drying (in which condition a considerable part of the Pacific coast catch is sold) of 70 per cent. Some of the by-products, such as tongues and livers, are utilized, however.

In preparing "boneless" fish (removing the skin, most of the bones, trimming, etc.) there is a loss of about 25 per cent from the flake-dried weight, while in preparing "absolutely boneless" (removing the skin, all the bones, trimmings, etc.) there is an additional loss of 5 per cent, making 30 per cent of the flake-dried weight. In preparing "boneless" and "absolutely boneless" fish the skins, bones, and trimmings are saved and disposed of to the glue makers.

A comparatively small part of the catch is hard dried for export, and the packers estimate that 150 pounds of dried fish are required to make 100 pounds hard dried.

PREPARING COD FOR MARKET

As soon as a fishing or station vessel reaches its home station the fish are landed and put into long troughs filled with water, where they are cleaned with brushes. They are then put into butts in the storage houses, backs down (except the top layer), salt being sprinkled between each layer, the amount used depending upon the degree and length of salting on the vessel. On top of the pile is placed about half a bushel of salt to strengthen the weak pickle that floats up to the surface. If the fish have been salted but lightly on the vessel one or two bags of salt are laid on top of the fish and the salt allowed to melt gradually. The fish remain in the butts under shelter until orders are received, which may be a year or more; in that case more salt is added from time to time, but the sooner they are used after the first few weeks the better, otherwise they have a tendency to turn yellow. Sunlight also will turn them yellow, so every effort is made to keep the storage house in deep shadow. The butts are either immense hogsheads or square tanks made of bolted timbers, and are used over and over again for years.

The curing of salt fish depends upon drying, and this is accomplished in three ways—by the use of salt, by pressure, or by exposure to the air either in the open air or in a drier. On this coast all three agents are employed.

When the fish are taken out of the butts they are piled in a kench or water-horsed to drain off part of the brine and to give the fish a smooth appearance. The fish are stacked face down, with the exception of the lowest layer in contact with the rack, in kenches about 4 feet high. If there is urgent demand for them they are left in this condition for 24 to 48 hours. If more time can be allowed they are repiled at the end of the first or second day, so that the fish on top may go to the bottom and be subjected to pressure

to squeeze out part of the water. If the weather is unfavorable for drying the kench is repiled every second or third day, and this may be continued for 10 days or more. With full-pickle fish, such as are prepared on this coast, it is not necessary to kench or water-horse so thoroughly as in the case of slack-salted or hard-dried fish.

From the water-horse the fish go to the flakes, which are of two kinds, stationary and canting, the former being the more common. The flake consists of a lattice bed about 8 feet wide, 30 inches high, and as long as the requirements may demand. The lattice used on this bed is made of triangular strips 1 inch on the base, placed about 3 inches apart. The fish therefore rest upon a sharp edge about every 4 inches, this giving the maximum circulation of air about the fish. The canting-flake frames, of which there are a number in use on this coast, are fixed only at the middle and to a horizontal axis, so that they can be turned at an angle with the horizon, in order to expose only the edge of the fish to the sun and to get the benefit of even a slight breeze. They are practical only in yards running north and south.

Rectangular boxes, with peaked roofs, known as "flake boxes," are used for covering the fish, when gathered together in small heaps, from dampness or rain. This box is generally 38 inches long, 22 inches wide, and 14 inches high, the whole being made of three-fourths-inch rough boards.

The fish are spread out carefully on the flakes with the face side up, and the drying is continued as long as may be necessary for the particular grade of fish. The full-pickle fish are dried for the shortest period, as they can not be skinned readily if too dry; and, furthermore, the trade seems to desire fish that are moist and not too hard, and these retain practically 50 per cent of their water. If the sun is fairly warm and there is a good breeze, the drying can be accomplished in about 10 hours as the minimum time, but this may be greatly increased with unfavorable weather conditions. Only one drying is usual for the full-cured fish.

Fish intended for Porto Rico or export usually are kenched directly from the vessel and not placed in butts. When needed they are dried for three days, "sweated" for two days, then dried again for two days. The object of the sweating is to bring the moisture out of the interior of the fish. The drying on the flakes removes the moisture from the surface and crystallizes the salt, but to get the moisture out of the center of the meat the fish must be piled in the kench, where the dry salt takes up some of the remaining moisture so that the second drying on the flakes has a greater effect. The export fish usually are dried sufficiently hard to withstand the pressure of the thumb in the thick part of the flesh without retaining the impression. The full-pickle fish lose about 9 per cent of their weight in drying on the flakes. When cured they retain about 50 per cent of their moisture, and the hard-dried from 25 to 30 per cent.

The sanitary conditions around a flake yard must be looked after carefully, as otherwise flies will breed and cause fly-blowing on the slack-salted fish.

Nearly all of the home stations on this coast have large artificial driers. These consist of inclosed rooms in which there are shelves of hot-water pipes, above which trays of fish are placed, and the air is made to circulate over them by means of a large fan. These dry

kilns are used chiefly in the drying of export fish. During foggy and damp weather and in winter when sunlight is rare they are used frequently.

After the fish have been dried they are carted to the storeroom and kenched until packed for shipment.

If the fish are to be boned and skinned they are taken to a separate room. Here the operator first cuts off the dorsal and ventral fins, then starts the skin at the napes and pulls it in toward the middle of the back and then toward the tail. If the fish has been cured properly the skin can be stripped off clean without tearing the flesh. The tail is then cut off, after which the fish is turned over and the nape bones removed with a small iron gaff called a "bone hooker."

FIG. 16.—Making cod bricks

The remaining portion of the backbone is cut out and the pectoral fins cut off. If it is to be put up as "absolutely boneless" the fish is passed to the bone pickers, who remove with forceps the ribs and any pieces of bone left in the body. If the fish are to be packed as so-called "boneless," then the fins only are cut off and the thick part of the backbone cut out closely, the small pieces of the fins, ribs, and backbone being allowed to remain.

The United States Department of Agriculture, in "Service and Regulatory Announcements No. 24," issued January 9, 1920, rules as follows in the matter of labeling codfish from which part or all of the bones have been removed, and it behooves all packers of codfish to study this closely:

Some manufacturers are placing on the market packages of codfish labeled as "boneless" from which only a few of the larger bones have been removed.

Other similar products, from which all or practically all the bones have been removed, are sold under such labelings as "absolutely boneless," "strictly boneless," and "no bones." Investigation by the bureau has shown that a very small part, if any, of the retail trade and consuming public is familiar with the distinction, and that a practically boneless fish is expected by them whenever the word "boneless" appears on the label.

The word "boneless" should be limited to the labeling of those products from which all or practically all the bones have been removed.

In making "bricks" or blocks the fish are cut to the desired size on a table made of blocks with openings between them at regular intervals. The fish, sometimes as many as eight or nine, are laid one on top of the other on the cutting table so that the best parts come between the openings. Then a long-bladed knife is driven through them and they are ready to be packed into bricks, etc. A trough, or miter box, also is used for securing the same result.

The pieces of fish are passed to girls, who sort them and weigh out exactly a pound or 2 pounds, whichever the weight of the brick is to be. Two good slices are selected to make the outside of the package and short or narrow strips to make up the middle part. The weighed fish is passed to the brickmaker, who selects first the piece that will make a whole side and an edge, and places it in the galvanized-iron mold; the smaller pieces are then put in, and lastly the remaining large piece to make a side. The selecting and placing of the pieces in such a way as to make the best appearing cake is quite a knack. The mold, which is 6 inches long by 3 inches wide and 3½ inches deep, is pressed tightly by foot or hand power, held for a few seconds, and then strings, which had previously been placed across the bottom of the mold in grooves left for the purpose, are tied around each end. The package is then completed by wrapping in paraffined or parchment paper with receipts and other matter printed on it. Some packers wrap in the parchment or paraffined paper and then inclose in a lithographed wrapper. There are several grades of bricks, depending upon the appearance and color of the fish, the choiceness of the pieces used, and the special curing to which the fish was originally subjected. Twenty-four 1-pound, twelve 2-pound, or twelve 3-pound bricks make a crate or case. The "boneless" fish put up in 5-pound boxes, but not pressed, run 12 to a crate.

Several forms of presses are used in this work, the most common consisting of a sliding box having two or three compartments, each of the size desired, and so arranged that a hand or foot lever forces a block down in one compartment at a time. The pressure remains while the fish are being placed in the second compartment, and when it is released the box is slid along until the second compartment comes under the press, when the brick in the first compartment is removed.

Shredded codfish, known as "desiccated codfish," "fibered codfish," "flaked codfish," and "skriggled codfish," is made up from the trimmings not otherwise used in packing the regular tablets, and is prepared on this coast by only one company. The material used is as good as any employed, but the pieces are too small to be used in the regular brick. They are run through a machine that tears the muscle into small fibrous bundles. In order to get this very fine and fluffy it may be necessary to press out part of the water after the first treatment and run it through the machine again, and then sift

it to free it from all particles of bone. The shredded fish is put up in 5 and 7 ounce cartons and jars, the latter being hermetically sealed in vacuum. Twenty-four boxes or jars make a crate.

A considerable quantity of skinned cod is put up in 100-pound cases. These are divided into "Large whole," "Extra large whole," and "Eastern style." These cases contain some of the finest of the whole cod cured, and the grade is fixed by the number of fish in the case. The last named are packed in eastern wood and are supposed to resemble most nearly the eastern fish of the same size and style of preparation.

The Porto Rican export, or hard-salted fish, are packed in drums, boxes, and bundles to suit the order, but there are regular drums

FIG. 17.—Cutting strips for the making of cod bricks

for 50, 100, 200, 300, and 448 pounds. The 448-pound drum is used very largely in the Porto Rican trade. The fish packed in drums are all well dried.

When placed in drums the fish are arranged carefully in circular fashion, with the flesh side up, until several layers have been put in, and then a layer is placed backs up. The fish are then well tamped with a heavy wooden tamper. Fish are again added and the tamping repeated at intervals. When the last fish are piled on the drum they will extend several inches above it, and a ratchet or a hydraulic press is necessary to force them down so that the head can be put in.

During the winter months a small business is done in preparing bacalao for the San Francisco trade. Usually this business is controlled by eastern packers who use the very small haddock in preparing it. Occasionally small haddock are not available from east-

ern waters during the winter season, and it is then that the Latin-speaking peoples of California fall back upon the local packers for their supplies. Small snappers, of which there is never a large supply on this coast, are used, and the fish are hard dried and then packed 100 pounds in a drum. It is fortunate that the business is not more extensive on this coast, as it means a heavy drain on the young cod, which, if allowed to live a year longer, would be much enhanced in value.

Large quantities of cod are sold after having been water-horsed and packed in bundles weighing 50 to 100 pounds. These fish are not skinned. A considerable trade in this grade of fish is had with the Hawaiian Islands.

Skinned fish are put up in strips and middles also. The strips consist of one-half the fish split down the middle and are cut to suit the trade—some left whole and some with more or less of the nape and thinner portion at the tail cut off in order to get heavy pieces. These are put up usually in 20 and 40 pound boxes. The middle is the whole fish after being skinned and the napes and tail cut off; how much of the napes and tail is cut off depends upon the number of middles permitted in a box of a certain size. They are quoted usually by the size—8 to 10 or 10 to 12 in a 40-pound box. They are also packed in 60-pound boxes. Frequently each individual fish is cut transversely the width of the box and folded over itself. Thick fish sometimes are cut transversely and each piece split and folded over in such a manner that the clean cut appears outside. Sometimes the fish are cut transversely across the fiber and tightly packed in boxes with the fiber running perpendicularly.

The trade in brine-salted codfish on the Pacific coast is small and is confined exclusively to the small fish or snappers. In pickling, the fish are dressed, split, washed, and salted in butts in the same manner as has been noted heretofore in the preparation of dry-salted cod. When shipment is to be made the fish are removed from the butts, cleaned with brushes, and placed in tight half barrels, flesh side up, except the top layer, which is placed backs up, the fish being bent to follow the curve of the half barrel. It is important that the fish be not repacked until thoroughly struck, otherwise the flesh will be marked with yellow spots caused by contact of the imperfectly cured fish with each other. Salt is placed at the bottom of the barrel and over each layer of fish, from one-half to three-quarters of a peck being used to each half barrel of fish. The barrel is then headed and strong brine added through the bunghole. About 38 medium-sized snappers are required to fill a half barrel. Most of these fish are sold to coasters plying up and down the coast and are fed to the crews.

The station fishermen frequently prepare a cod delicacy that they enjoy very much. Selecting a suitable cod stomach, the fisherman carefully cleans this inside and out. Several fresh, healthy cod livers are then picked out, chopped fine, and mixed with a little flour and vegetables; the stomachs are stuffed with this mixture, after which they are cooked like sausages.

Stockfish.—Of recent years a considerable business has developed in the preparation of stockfish. A number of small shore stations in the Shumagins and elsewhere, spend a considerable part of their

time on this work during the colder portion of the year, while a few individuals occasionally have put up varying quantities.

In preparing stockfish the fish are split in the regular way to a spot a little below the vent. The backbone is then removed and the fish split into two equal halves as far as the first cut extended. Snappers are sometimes merely gutted.

The drying yard comprises a network of wires running from crosspieces nailed onto uprights. The fish are hung over these wires, flesh side in, and supported by the undivided portion of the tail. Here they are allowed to cure in the sun and wind, no salt at all being used, sometimes for as long as six or seven weeks, the length of time depending upon how much moisture there is in the atmosphere. During long-continued rains the fish are stored under cover, but it does not hurt them to remain out during ordinary rains. When bone-dry the fish are stowed away in dry, cool houses, and when shipped are bound by wires into bales.

This work is carried on in winter, which is the only season when comparatively dry, cold weather is experienced in the Shumagins. In shipping and storing these fish great care must be exercised to see that they are not placed in a damp room, or that anything damp comes in contact with them, as in that event they will become slimy.

Fish prepared in this manner will keep for a much longer period than when prepared by any other method. It is much practiced by the Norwegians.

When desired for the table a sufficient number are put to soak in water and remain there four to five days, the water being changed every day. When of the desired softness the fish are put in fresh water with some lye and allowed to remain about 24 hours. The lye cuts the slime from the fish and gives it an added flavor.

Tongues.—Cod tongues are saved whenever possible. On the vessels one of the dress gang usually cuts them out, while at the stations some one other than a regular fisherman usually does this work. A cod's tongue is attached to the lower jaw, and when cut out includes all that part of the jaw lying inside the jawbone. When cutting tongues the operator takes hold of the fish by the back of the head, using the eyes for finger holds. As he lifts the fish by the head its mouth usually falls open, then with his other hand he cuts the tongue loose on the sides with a sharp knife, then cuts loose the lower end along the curving bone forming the back part of the lower jaw. The tongue is then hanging by a thin strip at the forward end of the jaw, from whence it is torn loose by the hand. The tongues are cured loosely in barrels with salt, and after being thoroughly struck are packed in barrels holding 200 pounds, which are headed, after which a strong brine is added through the bung. They are sold in these barrels or else repacked in half barrels, pails, and kits. Some are mixed with sounds and sold as tongues and sounds. As no sounds are saved on this coast, eastern sounds are employed in packing the latter.

Codfish tongues, especially when fresh, are considered a great delicacy. They are thoroughly washed in order to clean them, then dried with a clean cloth, rolled in bread or cracker crumbs, and fried the same as oysters. The salt tongues can be prepared in the same manner after having been soaked thoroughly in fresh water.

The packers never overstock with codfish tongues if it can be avoided, as in a year or two part of the tongue hardens, thus making it worthless as food.

Canning.—On the Atlantic coast a considerable quantity of cod is canned annually under the name of "codfish flakes." An even greater quantity of hake, haddock, and cod are canned together under the name of "fish flakes." The opportunity for canning cod is especially good on the Pacific coast. Several of the salmon canneries are located in close proximity to the cod banks, and as these plants already have the machinery and employees needed for carrying on this work in addition to the canning of salmon, cod could be canned much more cheaply than if a plant had to be erected especially for the work. As no other members of the Gadidæ other than the true cod are available on the Pacific coast for this work, the product could be sold under a cod label, which would enhance its value considerably. In 1916 the Pacific American Fisheries Co. began the canning of cod at its canneries along the Alaska Peninsula. Early in the season, before the salmon appeared, several purse-seine vessels were equipped with dories and hand lines and these fished on the North Pacific and Bering Sea banks. The fish were brought in fresh and canned. The following was the pack for the three years when canning was practiced:

Year and kind	Cases	Value
1916:		
½-pound flats	463	$1,389
1-pound flats	237	948
Total		2,337
1917:		
½-pound flats	567	2,339
1-pound flats	2,070	12,420
Total		14,759
1918:		
1-pound flats	2,336	14,175

In this experiment, as in most of the others undertaken in recent years on this coast, the packers followed too closely the methods in vogue in canning salmon, and as a result the product did not meet with the favor it probably would have had if other methods more suited to cod had been followed.

There is no doubt in the author's mind but that the canning of Pacific cod eventually will furnish an important consuming market for this excellent fish, and it is the intention of the author to take up immediately at the College of Fisheries, University of Washington, the problem of how best to can Pacific cod, and as soon as satisfactory results are obtained they will be made public.

Cod-liver oil.—At an early date in the fishery, oil was being extracted from the livers of cod. In 1866, 10,000 gallons were reported as having been rendered, which statement seems somewhat of an exaggeration when the then extent of the fishery is taken into account. In 1879 Lynde & Hough are reported as bringing to San Francisco 3,000 gallons of oil. In later years a small quantity was

prepared each season, the quantity depending upon the demand and price.

All the oil was prepared by rotting the livers in large vats or hogsheads, and the resulting product, after being strained, was shipped in this condition.

In 1899 the Alaska Codfish Co. installed a refining plant at its Kelleys Rock station, in Alaska, and operated it successfully until 100 barrels (iron-lined receptacles holding 20 gallons) had accumulated, when they were brought to San Francisco and the oil offered for sale to makers of emulsion of cod-liver oil. At that time the market was overloaded with this grade of oil and the best price offered was about what the container cost, so the oil was stored and the plant shut down. A few years later the market picked up and the oil was disposed of at $22 per barrel. In the meantime the company's oil maker had disappeared and the plant was so badly dilapidated through the action of the elements that the industry was not resumed.

Later the Union Fish Co. erected a plant at Pirate Cove, but after refining a small quantity at no profit to the company this plant was also shut down and has remained so ever since.

At present the small quantity rendered is shipped just as taken from the rotting tank, except that it is first strained.

Glue and fertilizer.—As early as 1893 a plant was started in California for the purpose of manufacturing glue from codfish skins and other refuse of the packing plants in the States. The material remaining after the glue had been extracted was prepared and sold as fertilizer. There are now two plants at Anacortes, Wash., and one in California that prepare glue in whole or in part from cod.

It is to be hoped that in the near future small plants for the manufacture of glue and fertilizer will be established at certain centrally located stations in Alaska, where the large quantity of heads, entrails, and spoiled fish can be utilized and not, as now, thrown into the water under the dress houses, where they pollute the water, while the bones remaining after the flesh has rotted away are gradually filling the smaller harbors.

USE OF PRESERVATIVES

In 1881 boracic acid was introduced as a preservative in the fish industry and was used continuously until 1907, when it was generally superseded by sodium benzoate. Boracic acid is employed but rarely on this coast at the present time, and when so employed it is on export fish. If this acid is used, it is applied to the fish when they are being shifted in the water-horse or to the outside of the completed codfish brick.

Sodium benzoate is almost solely the only preservative used on this coast. It is mixed with finely ground salt and applied by means of a powdering can, like a large pepper box. It is used upon the fish in the storeroom if the weather conditions demand it, but its principal use is upon the fish as they are being weighed out into tablets and bricks. This preservative is used chiefly during the warmer months. The amount used is not weighed but is dusted on to cover the whole surface, the effort being to apply from 0.3 to 0.4 per cent. When this preservative is used the package of fish bears

the following label or stamp: "Sprinkled with one-half of 1 per cent soda benzoate. To remove, soak out in fresh water."

Preservatives are never used upon fish shipped to near-by points or if the fish are to be consumed very shortly after being shipped. Its use is generally upon fish shipped abroad, or fish shipped considerable distances in this country during the summer months.

MARKET FOR PACIFIC COD

The development of the demand for Pacific cod has been one of slow growth against great obstacles. In the early days of the industry all of the catch was marketed on the coast, and as salt fish was scarce and in good demand, fairly good prices were obtained for an article which, in many instances, was only indifferently cured. The success of the pioneers led to a rapid expansion of the industry, with the result that the local market was soon overstocked and the curers had to look to the Middle Western and Eastern States and abroad for a market for the surplus.

At this period the eastern curers, and the large wholesale salt-fish houses scattered throughout the country who purchased their supplies from them, controlled the markets for cod throughout the United States, while all of the cod exported from this country went from New England. Naturally these curers, and the wholesalers dependent upon them, did not welcome the intrusion of Pacific cod, and while they were unable to prevent the loss of the greater part of their trade on the Pacific coast, they fought hard for the rest. Dealers and consumers were told in some instances that the fish prepared by this coast's curers were not cod, or that they were a very inferior grade of cod; that the fish would not keep, etc. That these misstatements had a wide dissemination and made a considerable impression is evidenced even to this day in the prejudice which is met in different sections of the country against Pacific cod.

Unfortunately, the Pacific coast producers, through ignorance, played right into the hands of their trade enemies when first invading the territory hitherto held by them alone. Some of the fish were poorly prepared and part of them were shipped across the continent during a season when the weather was warm, and as they had been stowed in ordinary box cars, the temperature of these corresponded to the weather, so that the fish arrived in the eastern market in very poor condition, thus disgusting the few dealers who had been willing to give them a trial. The shippers quickly discovered their error and afterwards restricted shipments for long distances to the colder months of the year and also used refrigerator cars. The damage had been done, however, and from then on it was slow and discouraging uphill work to extend the market for Pacific cod east of the Rocky Mountains.

The fight of the Pacific cod for admission into eastern markets is a typical example of how difficult it is to overcome a prejudice, no matter how insufficiently founded.

On the Pacific coast but one species of the Gadidæ, the true cod (*Gadus macrocephalus*), is to be found of a sufficient size for dry-salting, and as a result is the only species sold in any condition other than fresh. At the very time when the dealers were refusing Pacific cod, and for a number of years after, the vast majority of

them were purchasing from eastern curers hake, cusk, and pollock, closely related species to the true cod, but much cheaper, and, in the opinion of those best informed, much inferior to the true cod, and were selling these as true cod along with the cod itself. The pure food law compelled the dealers to sell the fish for what they really were, and as a result the market for the Pacific cod has been widening rapidly ever since.

Being shut off from Europe and the east coast of South and Central America by high freight rates and the great distance the fish had to travel, the Pacific dealers directed their efforts toward Mexico, the west coast of Central America, the islands of the Pacific, and Asia with most gratifying results. At one time a large business was done with Australia, until that Commonwealth enacted a stringent law prohibiting the use of preservatives on shipments of salt fish into that country. As the goods had to pass through the Tropics on their way to Australia, and the Australians are not accustomed to using hard-cured fish, heavy losses through fish spoiling resulted from this prohibition and the market there has been curtailed as a result.

Despite the natural and artificial handicaps under which the industry suffered, a considerable trade has been developed in the West Indies, and this was enlarged during the European war. The Norwegians, who formerly shipped large quantities to this section, have found a new market in Germany. While the close of the war forced trade largely back into old channels, many markets had tested the excellence of Pacific cod and continued to use them whenever possible. The opening of the Panama Canal also greatly aided in the expansion of the trade in this section of the world.

The Asian market undoubtedly in time will attain to large dimensions. At present, and for a number of years past, it has been widening steadily as the fish became better known and the means of transportation increased.

Hawaii consumes large quantities of cod, and the greater part comes from the Pacific coast. San Francisco dealers ship nearly all of the bundle fish (fish that have been water-horsed and put into bundles of 100 pounds each and bagged) and a considerable part of the cased cod, while the Puget Sound dealers ship mainly cased fish.

Mexico is rapidly developing into an excellent market for Pacific cod, mainly for cased fish that have been dried harder than for consumption nearer home.

The increase in steamship lines to South and Central America, due to the opening of the Panama Canal, will aid greatly in widening the markets for Pacific cod in that region of the world.

The demand on the part of the public for dried cod is not what it ought to be, and a good part of this lack of demand is due to the archaic methods of doing business prevalent not only in the Pacific cod industry but also in that of the Atlantic.

If the shippers of codfish were to copy somewhat the methods followed by the meat packers they would have less loss from spoilage, while the fish would present so much nicer an appearance that the demand for it would increase materially. The only difference between salted meat and salted fish is that the latter is less liable to spoil.

When shipping to the Atlantic seaboard the dealers usually select the season from November to March and load the fish in refrigerator cars. The latter are cooled but little during the shipment. In shipping lesser distances the fish usually are stowed in ordinary box cars. Sometimes these box cars are shunted onto sidetracks and held for days at a time, and should the temperature rise above 65° F. during this period and under these conditions reddening is apt to appear.

The better plan is to have cold-storage depots located in trade centers. The fish could be shipped in refrigerator cars to these depots frequently, where they could be put in storage. The retailers could then be encouraged to order the fish in small lots, say, enough to last for a week or 10 days, and thus they would always have on hand comparatively fresh fish.

In their eagerness, however, to do business the jobbers frequently overload the retailer, with the result that the fish dry out to such an extent that the salt crystallizes upon it and the fish presents an unattractive appearance, while if the temperature rises above a certain point reddening is apt to occur should conditions be ripe for it.

Grocery stores are the chief handlers of cod, and but few of them are properly equipped for doing this. It is but rarely that a customer who enters one of these stores will see dried cod on exhibition; or, if he does, it is usually whole fish jumbled up in a case and presenting an unattractive appearance. Usually the fish is kept in a back room or the cellar and is brought out only when the customer orders it. As many customers are in an uncertain frame of mind as to what they want when they enter a store, and usually decide after a glance over the visible stock, it follows naturally that but few ever order salt cod, and, owing to the extra labor involved in bringing the cod from the back room or cellar, the clerks rarely ever call the customer's attention to its existence.

If the retailer fitted up a small refrigerated show case with glass sides and top somewhere in the store proper, he could not only keep in this his dried cod, especially the bricks, tablets, middles, etc., which could be tastefully arranged on china trays, but could also display a number of other articles that require to be kept in a cool place and that usually are sold in grocery stores, such as smoked fish, pickled fish, etc.

With the fish displayed thus prominently before the customer, his attention is at once attracted to it, and he is much more liable to purchase it than if the product were kept out of sight and only produced when a customer called for it.

The greater part of the bricks and tablets are now wrapped in white parchment paper with the brand and a little lettering printed on it in a neutral tint. A few of the more progressive dealers wrap them in the parchment and then inclose the package in an ornately lithographed wrapper. The latter makes a very attractive appearance and undoubtedly aids in calling the attention of the consumer to the product, particularly if it is displayed as recommended above, as is the case in a few of the high-class delicatessen stores. An even better method would be to pack the bricks and tablets in lithographed cartons made to hold certain sizes. On one side recipes for cooking

and preparing the fish should be printed; if the fish is improperly prepared by a cook unfamiliar with it, those who partake of it are not likely to want it again.

COMPARATIVE ANALYSES OF PACIFIC AND ATLANTIC COD

Much has been said and written about the alleged superiority of Atlantic over Pacific cod. While there are a number of analyses of Atlantic cod extant, the same, unfortunately, is not true of the Pacific cod. The only one available is that made for the Robinson Fisheries Co., of Anacortes, Wash., and the subject was a sample of shredded Pacific cod. Fortunately, there is one analysis of Atlantic shredded cod with which it can be compared. The analyses follow:

Comparison of Pacific and Atlantic shredded codfish

	Pacific cod [1]	Atlantic cod [2]		Pacific cod [1]	Atlantic cod [2]
	Per cent	*Per cent*		*Per cent*	*Per cent*
Water	43.90	46.52	Phosphoric anhydride	0.69	----------
Protein (calc. from nitrogen)	37.19	30.85	Sulphuric anhydride	.07	----------
Protein (calc. from differences)	35.00	----------	Chlorine	11.37	----------
Fat	.73	.33	Fuel value per pound		
Ash	20.37	22.81	----------calories (calc.)	682	578

[1] Analysis made by Stillwell & Gladding, New York, N. Y.
[2] Foods and Their Adulteration, by Dr. Harvey W. Wiley, p. 126. Philadelphia, 1907.

REDDENING OF COD

A source of considerable expense and annoyance to the codfish packers is the occasional reddening of the fish. While not so common on the Pacific coast as on the Atlantic and European coasts, due to the much lower mean temperature during the warm months and possibly the grade of salt used, yet it does appear at times.

Codfish and some other salt-cured fish are subject to spoilage when exposed to a temperature above 65° F. The spoilage is manifested by the surface of the fish turning red. This is an old complaint on both coasts and in Europe, and has been increasingly expensive on the Atlantic coast, as the expansion of the industry has necessitated the marketing of greater and greater quantities of fish during the warm months of the year. It appears only on the dry-salted fish, as fish completely submerged in pickle seems to be immune so long as it is retained there.

The fist sign of redness appears when the dried fish are stored on the ground floor and before the skinning and packing are done, but frequently it may not appear until many days after the fish has been packed and shipped.

Reddening is essentially a surface infection. Except as it follows fissures in the muscles, cuts, or breaks where the air has free access, it does not appear below the surface. On the whole fish the favorite point of attack is near the backbone, and this is due to the greater thickness of flesh, which insures more moisture at all times. It is more often found upon the outside of the bricks or tablets. Sometimes the affected fish is of a pale, pink color, at other times a bright red.

Reddening of cod has been studied by a number of scientists.[17] Research has shown that it is due to bacterial activity. There is disagreement, however, as to whether it is caused by one or more organisms. On the other hand, all investigators who have recently studied the subject agree that the bacteria that cause reddening grow best in strong salt (even saturated) solutions. Fresh water kills them. A plentiful supply of air and moisture is necessary for growth. At 50° to 55° F. growth is very slow. With increasing temperatures, providing sufficient air and moisture are present, growth increases, taking place most rapidly between 120° and 140° F. The bacteria are killed when kept in dry air for 30 minutes at 248° F.

Experiments have shown definitely that the infection comes from the use of salt obtained from sea water by solar evaporation. Salt from underground mines is not infected. Examination has shown that in most establishments the tanks, tables, floors, walls, and other parts of the curing houses and rooms where the cured fish are handled are more or less infected with reddening bacteria.

The remedies suggested by Harrison and Kennedy[18] for diminishing and preventing reddening follow:

The most important point arising out of these experiments is the fact that the tropical or solar salts carry the red organism, and so long as they are used in their present form, red coloration of fish is bound to follow.

Curing establishments that use this salt, or have been using it, have their tanks, floors, storage places, puncheons, kench racks, carrying boxes, utensils, etc., impregnated or inoculated with the red organism.

Therefore, all measures taken to deal with this problem must provide for:

1. A supply of salt free from the red organism.

2. The destruction of the red organism in the curing factories wherever it has infected buildings, utensils, etc.

1. *Recommendations regarding salt.*—Mined salt of suitable size of grain should be used until a supply of solar salt free from the red organism can be secured.

Importers of solar salt might sterilize this product by kiln heating. A comparatively low dry heat is necessary—100° C. for 30 minutes.[19]

2. *Recommendations regarding cleaning of curing establishments.*—All curing establishments which have used solar or tropical salts should clean and disinfect thoroughly all material which has come into contact with salt or fish.

Steam, if available, may be used for this purpose. Puncheons, tanks, etc., should be steamed inside and out, also all utensils, racks, etc.

All parts of the factory that have become infected should be washed well in fresh water. This will have two results: The removal of salt from woodwork, thus preventing the organism from growing, and the fresh water causes the disintegration of the red organism, breaking it down into a slimy mass.

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[17] Preparation of the cod and other salt fish for the market, including a bacteriological study of the causes of reddening. By A. W. Bitting. United States Department of Agriculture Bulletin No. 133, 63 pp., illus. (1911). Washington.

Report of progress of biological inquiries. Report of the division of scientific inquiry for the fiscal year 1920. By R. E. Coker. Appendix II, Report of the Commissioner of Fisheries for 1920 (1921), pp. 27–28. Washington.

Red discoloration of cured codfish. By F. C. Harrison and Margaret E. Kennedy. Report 11, the Honorary Advisory Council for Scientific and Industrial Research (1922). Ottawa, Canada.

Red discoloration (so called "pink" or "pink eye") on dried salted fish. By P. C. Cloake. Department of Scientific and Industrial Research, Food Investigation Board, Special Report No. 18 (1923). London.

[18] Red discoloration of cured codfish. By F. C. Harrison and Margaret E. Kennedy. Report 11, the Honorary Advisory Council for Scientific and Industrial Research (1922). Ottawa, Canada.

[19] At least one other investigator (Cloake) does not believe 212° F. is sufficient to sterilize the salt in 30 minutes, and recommends 248° F. Undoubtedly a much higher temperature than either of these will prove more practical because of more rapid sterilization at the higher temperature. Salt can be heated to temperatures in excess of 1,000° F. without bad effect, if desired.

All places infected, and all utensils, may be washed in a disinfecting solution of 1 part sulphurous acid in 50 parts of water.

A good whitewash should be applied as soon as the cleaning up has been effected.

Care should be exercised to keep the premises and utensils clean, all refuse and offal should be frequently removed, and the floors scrubbed and washed often.

BROWN MOLD

Brown mold, which forms brown, frecklelike spots on partly dried fish, occurs but rarely on this coast. It occurs usually on old fish, but may be found on comparatively fresh fish also. The fungus affects both sides of the fish, even covering the fins and tail. When it is found on comparatively fresh fish, they are scrubbed with a brush in running water, after which they are powdered. But little attention is paid to this fungus by the packers.

JAPAN AS A COMPETITOR

For a number of years Japanese fishing vessels have been resorting to the Asian cod banks, located in Bering Sea, Sea of Okhotsk, Japan Sea, the waters of the Kurile Islands, and Hokaido, and the Yellow Sea. Before our San Francisco fleet (in 1910) stopped going to the Okhotsk Sea banks they reported seeing numerous Japanese schooners on those banks.

Trawl lines are used on the near-by banks. A 200-fathom main line, with 100 or more gangeons with hooks attached, makes a "basket," and each boat carries 14 to 15 such baskets. The bait used are herring, squid, flounder, salt sardines, and octopus, and the fishing season is usually from January to April.

The larger schooners—from 100 to 150 tons—operate mainly in the waters around the Kurile Islands and in Okhotsk Sea, and the vessels generally, as on the American side, leave the home port during the early part of May and return the latter part of October. Usually about 100 days are actually spent in fishing, the best period being during July and August. Hand lines are used by the fishermen and these usually are fished in 90 or less fathoms, two hooks being employed. Herring, mackerel, or codfish are used as bait.

The Okhotsk Sea fishermen salt their fish in the hold as our fishermen do. However, two methods of dressing are followed. In one the fish are split down the belly and the head is removed, as is the custom with our fishermen, while in the other the fish are split down the back, as is done by our mackerel fishermen, and the head is left on. These are called by the Japanese "open cod." Those split down the back are dried and packed in straw mats or in boxes for export to China, where a considerable market has been developed for them. The open cod, with head off, is usually put up during the winter months and sold largely in Japan.

Stockfish, or "stick cod," as it is known locally, is also prepared in the same way as in Alaska.

The home phases of the industry are centered largely in Hokkaido and Sakhalin Island, or Karafuto, as it is known in Japan.

The Japanese at first gave their attention to the supplying of other oriental markets with dry-salted cod and were measurably success-

ful, especially in China. They soon discovered, however, that the principal consumers of this excellent fish were Occidentals. A few small sample lots were shipped to American and other markets, but these proved unsatisfactory because of their unattractive appearance, due largely to wrong selection of fish to be used, the grade of salt selected, and poor methods of dressing and curing the product. The Japanese were quick to see what was wrong, and with their usual thoroughness sent out various trained men to study the methods followed in the producing countries and the likes and dislikes of the consuming markets. This was continued for a number of years and the product prepared by these men, or by the fishermen trained under them, slowly found its way into certain occidental markets.

The following table shows the importations into this country of dry-salted cod from Japan from 1912 to date:

Imports of cured and preserved cod from Japan, 1912 to 1922

	Pounds	Value		Pounds	Value
Fiscal year ending June 30—			Six months—		
1912	335	$14	1918 (July 1 to Dec. 31)	1,585,550	$107,185
1913	18	3	Calendar year—		
1914	1,060	26	1919	[1] 4,781,631	390,024
1915	868	57	1920	2,592,226	294,397
1916	5,223	232	1921	590,320	90,914
1917	69,432	4,570	1922	92,482	9,558
1918	190,554	17,511			

[1] Of these, 672,732 pounds, valued at $46,794, were from Russia in Asia.

The breaking out of the World War proved a golden opportunity for them. The combatants in Europe very quickly absorbed all of the European production, a large portion of which, especially from Norway, had previously found a market in the West Indies and South and Central America. A considerable part of the fish from Newfoundland, Canada, and the Atlantic seaboard of the United States, which previous to the outbreak of the war had also been marketed in the above sections, was attracted to Europe by the high prices. This led to a heavy demand for cod from the Pacific to supply the shortage created in South and Central America and the West Indies, and our industry enjoyed great prosperity from 1915 until the great slump came in 1921.

At the time when the war broke out salt codfish was on the free list, but it was difficult for foreign fishermen to ship fish because of the provisions in our law preventing a foreign fishing vessel from sailing direct from the fishing banks to one of our ports, selling its catch, outfitting for another trip, and then returning direct to the banks.

In April, 1918, in order to facilitate the importation of fish, the Secretary of Commerce issued an order suspending the operation of the law forbidding the landing of catches of foreign fishing vessels direct from the banks. The result was that Japanese fishing vessels were permitted to come here direct from the fishing banks (in a few instances the vessels caught their fish on the Alaska banks), market their catch, buy salt and other supplies, and return direct to the fishing banks. The Secretary's order was withdrawn on July 15, 1921. While the law was suspended the following Japanese fishing vessels landed cargoes as noted below:

Importations of cod from Japan

Vessels and importing points	Owner	Sailed from—	Date of arrival	Stock-fish, pounds	Dry-salted cod, number
1918					
At San Francisco:					
Nambo Maru	Japan Fisheries Co	Japan	Aug. 20		230,000
Tembo Maru	do	do	Nov. 5		78,000
Sobo Maru	do	do	Nov. 9		200,000
Ichikawa Maru	do	do	Nov. 26		220,000
Umbo Maru	do	do	Dec. 22	176,000	166,000
Total				176,000	894,000
1919					
At San Francisco:					
Nambo Maru	Pacific Trading Co	Japan	Jan. 24		184,000
Nippo Maru	do	do	Mar. 6		262,500
At Puget Sound:					
Sobo Maru	Japan Fisheries Co	do	Oct. 8		115,000
Nambo Maru	do	do	do		120,000
Ichikawa Maru	do	do	do		115,000
Fubo Maru	do	do	Oct. 23		216,000
Daibo Maru	do	do	Nov. 25		70,000
At Vancouver, B. C.:					
By regular steamers		do		630,500	
Total				630,500	1,082,500
1920					
At San Francisco:					
Masashige Maru	Pacific Trading Co	Japan	Nov. 25		92,000
At Puget Sound:					
Sobo Maru	Japan Fisheries Co	Okhotsk Sea	Oct. 24		156,000
Ichikawa Maru	do	do	Nov. 1		122,000
Nambo Maru	do	do	do		122,000
Okhotsk Maru	Royal Fish Co	do	Nov. 30		130,000
Total					622,000
Grand total				806,500	2,598,500

PACIFIC COD INDUSTRY IN 1924

Some differences will be found between the figures herein given for the cod industry of Alaska and the figures appearing in the report "Alaska Fishery and Fur-Seal Industries in 1924" (Bureau of Fisheries Document No. 992). This is because of the fact that certain items are included in this report that are not credited to the cod industry in the Alaska report cited above. The Alaska report includes only those fish actually landed in the Territory; also, there are credited to Alaska only those fishing vessels that were operated from shore stations, and the vessels engaged in transporting shore-station catches but that did not engage in offshore fishing. Later and more complete sources of information also were available in preparing the figures that appear hereinafter.

PERSONS EMPLOYED

The following table shows the number of persons employed in the various branches of the industry. Alaska leads in the total number by a slight margin over California. The latter State leads, however, in the number of fishermen and transporters. About 34 Indians were employed in Alaska. All others were whites.

Persons employed in the cod fisheries of the Pacific coast in 1924

How engaged	Alaska	Washington	California	Tota
In vessel fisheries: Whites	39	180	219	438
In transporting: Whites	8		18	26
In shore and boat fisheries:				
Whites	222			222
Indians	17			17
Total	239			239
In shore work:				
Whites	13	65	65	143
Indians	17			17
Total	30	65	65	160
Total:				
Whites	282	245	302	829
Indians	34			34
Grand total	316	245	302	863

INVESTMENT

Ten sailing vessels and six power vessels were engaged in fishing, while two sailing vessels and nine power vessels were employed in transporting. One hundred and seven power vessels, each under 5 net tons, and 356 dories were employed in all branches of the fisheries. With the exception of a few trawl lines used in the Alaska vessel fishery, hand lines were employed. California leads in the total investment, followed by Alaska and Washington in the order named. The high value of the investment in Alaska is due to the number of shore stations located there.

Vessels, boats, apparatus, shore property, and cash capital employed in the cod fisheries of the Pacific coast in 1924

Designation	Alaska		Washington		California		Total	
	Number	Value	Number	Value	Number	Value	Number	Value
Vessels fishing:								
Sailing			5	$51,000	5	$59,726	10	$110,726
Tonnage			1,448		1,757		3,205	
Outfit				80,184		80,000		160,184
Power	5	$33,500			1	27,000	6	60,500
Tonnage	80				115		195	
Outfit		11,033				9,000		20,033
Vessels transporting:								
Sailing	1	2,600			1	15,253	2	17,853
Tonnage	14				281		295	
Outfit		150				3,000		3,150
Power	8	71,800			1	43,000	9	114,800
Tonnage	126				223		349	
Outfit		20,376				5,000		25,376
Launches under 5 tons	106	92,570			1	3,500	107	96,070
Boats	123	4,950	103	5,460	130	6,500	356	16,910
Apparatus:								
Vessel fisheries—								
Hand lines	570	1,075	1,440	1,703	1,500	3,700	3,510	6,478
Trawl lines	12	200					12	200
Shore fisheries—								
Hand lines	1,391	4,529					1,391	4,529
Shore and accessory property		129,704		145,600		115,000		390,304
Operating capital		20,376		58,100		46,500		124,976
Total		392,863		342,047		417,179		1,152,089

PRODUCTS

The total quantity of cod landed in 1924 amounted to 8,805,705 pounds, valued at $543,496. This represents 2,784,857 fish, a comparatively small production for this coast. As the companies prepare and market their own fish in a dried, boneless, or pickled condition, the ultimate returns received by the companies will be much larger than is shown in this table.

The vessel fisheries produced 7,155,520 pounds, valued at $433,963, while the shore fisheries produced 1,650,185 pounds, valued at $109,533. The frozen cod reported was landed by halibut vessels.

Washington leads in the total quantity produced and is second in value of same, while California is second in quantity produced and first in value of same.

Products of the cod fisheries of the Pacific coast in 1924

Fisheries	Alaska		Washington		California		Total	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
Vessel:								
Cod—								
Dry-salted	301,090	$14,530	3,700,791	$176,815	2,878,028	$223,512	6,879,909	$414,857
Pickled	220,260	17,070					220,260	17,070
Frozen	45,951	1,378					45,951	1,378
Tongues			9,400	658			9,400	658
Total	567,301	32,978	3,710,191	177,473	2,878,028	223,512	7,155,520	433,963
Shore:								
Cod—								
Dry-salted	1,609,560	103,598					1,609,560	103,598
Stockfish	39,300	5,869					39,300	5,869
Tongues	1,325	66					1,325	66
Total	1,650,185	109,533					1,650,185	109,533
Total:								
Cod—								
Dry-salted	1,910,650	118,128	3,700,791	176,815	2,878,028	223,512	8,489,469	518,455
Pickled	220,260	17,070					220,260	17,070
Frozen	45,951	1,378					45,951	1,378
Stockfish	39,300	5,869					39,300	5,869
Tongues	1,325	66	9,400	658			10,725	724
Total	2,217,486	142,511	3,710,191	177,473	2,878,028	223,512	8,805,705	543,496

SUMMARY OF CATCH

The following table gives a complete summary of all the codfish secured in the vessel and shore fisheries from the inception of the industry and carried to the home ports in Washington and California. No effort has been made to include the cod consumed locally in Alaska, which, in the aggregate, amounts to considerable, as it forms the principal article of diet along a considerable stretch of Alaska's coast line. This table shows that 72,706,620 fish were secured in the vessel fishery and 38,226,218 in the shore fishery, or a grand total of 110,932,838 fish.

Summary of cod catch of Alaska

Year	Vessel fishery	Shore fishery	Total	Year	Vessel fishery	Shore fishery	Total
	Number	*Number*	*Number*		*Number*	*Number*	*Number*
1863	7,100		7,100	1896	837,000		837,000
1864	54,500		54,500	1897	850,000	511,000	1,361,000
1865	225,000		225,000	1898	342,000	450,000	792,000
1866	724,000		724,000	1899	783,000	722,000	1,505,000
1867	943,400		943,400	1900	817,000	909,000	1,726,000
1868	580,000		580,000	1901	787,000	727,000	1,514,000
1869	1,032,000		1,032,000	1902	1,229,000	1,140,000	2,369,000
1870	1,467,000		1,467,000	1903	1,463,800	985,000	2,448,800
1871	926,000		926,000	1904	1,546,524	1,002,000	2,548,524
1872	305,000		305,000	1905	2,332,133	1,282,000	3,614,133
1873	563,000		563,000	1906	2,492,618	1,020,632	3,513,250
1874	369,000		369,000	1907	1,490,230	1,518,951	3,009,181
1875	362,000		362,000	1908	2,028,000	1,146,403	3,174,403
1876	814,000	30,000	844,000	1909	1,748,155	910,361	2,658,516
1877	779,000	101,000	880,000	1910	1,291,500	683,475	1,974,975
1878	902,000	227,000	1,127,000	1911	1,542,000	992,000	2,534,000
1879	1,301,000	198,000	1,499,000	1912	1,348,000	997,934	2,345,934
1880	1,002,000	201,000	1,203,000	1913	1,481,260	804,097	2,285,357
1881	907,000	154,000	1,061,000	1914	2,283,202	1,585,600	3,868,802
1882	1,038,000	203,000	1,241,000	1915	2,733,571	1,068,015	3,801,586
1883	1,485,000	235,000	1,720,000	1916	2,733,400	1,159,107	3,892,507
1884	1,373,000	249,000	1,622,000	1917	2,492,960	1,348,000	3,840,960
1885	988,000	386,000	1,374,000	1918	2,379,347	1,446,410	3,825,757
1886	800,000	383,000	1,183,000	1919	2,013,537	1,596,802	3,610,339
1887	830,000	299,000	1,126,000	1920	1,680,867	1,925,182	3,606,049
1888	674,000	372,000	1,046,000	1921	608,000	1,642,090	2,250,000
1889	327,000	489,000	816,000	1922	1,161,000	838,300	1,999,300
1890	365,000	773,000	1,138,000	1923	1,754,468	1,170,375	2,924,843
1891	583,000	662,000	1,245,000	1924	1,938,207	846,650	2,784,857
1892	775,000	700,000	1,475,000	1925	2,055,875	884,924	2,940,799
1893	666,000	660,000	1,326,000				
1894	698,000	305,000	1,003,000	Total	72,706,620	38,226,218	110,932,838
1895	765,000	286,000	1,051,000				

SUMMARY OF VESSEL-FISHING DATA

The following table shows, in summarized form, the available data covering the vessel fishery for cod on the Pacific coast from its inception in 1863 to 1925, inclusive. In this table is shown, by years, the number of vessels from the States fishing on the various grounds, and the catch made on each ground. As after 1909 none of the vessels visited the Okhotsk Sea, while a little later the vessels visiting the banks off the Alaska coast often fished in the same season on both the North Pacific and Bering Sea banks, it was decided to combine these last-named two areas under the head of North Pacific banks. Up to 1915 the Alaska local fleet was so small, and separate data were so difficult to gather, that they were combined with those of the shore-station catch. Since then, however, an effort has been made to separate this. The total catch of the fleet since 1863 amounts to 72,706,620.

Summary of vessel fishing, 1863 to 1925

CALIFORNIA VESSELS

Years	Number of vessels engaged				Total net tonnage	Number of fish caught			
	Okhotsk Sea	Bering Sea	North Pacific	Total		Okhotsk Sea	Bering Sea [1]	North Pacific	Total
1863	1			1	120	7,100			7,100
1864	1	1		2		50,000	4,500		54,500
1865	6		1	7	449	210,000		15,000	225,000
1866			3	18		588,000		136,000	724,000
1867				20					943,400
1868	7		3	10	1,502	377,000		203,000	580,000
1869				21					1,032,000
1870	12		10	22		1,027,000		440,000	1,467,000
1871	5		8	13		532,000		394,000	926,000
1872	2		4	6		130,000		175,500	305,500
1873	5		5	10		352,000		211,000	563,000
1874			7	7				369,000	369,000
1875			5	5	506			362,000	362,000
1876	3		8	11		333,000		481,000	814,000
1877	5		6	11		426,000		353,000	779,000
1878	4		6	10		651,000		251,000	902,000
1879	5		7	12	1,858	843,000		458,000	1,301,000
1880	6		1	7	1,441	915,000		87,000	1,002,000
1881	5		2	7	1,441	764,000		143,000	907,000
1882	5	2	6	13	2,260	712,000	132,000	194,000	1,038,000
1883	7	5	2	14	2,837	983,000	381,000	121,000	1,485,000
1884	11	3		14	3,222	1,007,000	366,000		1,373,000
1885	4	3	3	10	2,287	493,000	296,000	199,000	988,000
1886	4	2	2	8	1,939	428,000	239,000	133,000	800,000
1887	2	1	4	7	1,558	331,000	185,000	311,000	830,000
1888	2	2	2	6	1,391	311,000	294,000	69,000	674,000
1889	2			2	623	327,000			327,000
1890	2	1		3	715	317,000	48,000		365,000
1891	1	5		6	1,232	171,000	387,000		558,000
1892	1	4		5	1,335	125,000	487,000		612,000
1893	2	3	1	6	1,460	341,000	215,000		556,000
1894	1	4		5	1,393	169,000	420,000		589,000
1895	2	4		6	1,518	248,000	405,000		653,000
1896	1	5		6	1,512	125,000	493,000		618,000
1897		5		5	1,393		554,000		554,000
1898		3		3	780		292,000		292,000
1899		5		5	1,174		580,000		580,000
1900		6		6	1,305		623,000		623,000
1901		6		6	1,540		702,000		702,000
1902		9		9	2,034		933,000		933,000
1903	1	7		8	1,899	170,000	867,300		1,037,300
1904	1	5	1	7	1,939	223,000	770,000	69,200	1,062,200
1905	4	7		11	2,928	636,000	700,133		1,336,133
1906	5	6		11	3,237	692,000	786,000		1,478,000
1907	4	4		8	2,400	271,800	470,000		741,800
1908	3	4		7	2,259	420,000	490,000		910,000
1909	1	4		5	1,416	80,000	520,000		600,000
1910		3		3	1,074		380,000		380,000
1911		3		3	993		439,000		439,000
1912		4	1	5	1,554		525,000	139,000	664,000
1913		4	1	5	1,554		587,000	130,000	717,000
1914		5	1	6	1,783		781,202	150,000	931,202
1915		6	1	7	2,175		1,134,500	119,000	1,253,500
1916			4	4	1,695			1,127,000	1,127,000
1917			7	7	2,392			1,352,000	1,352,000
1918			6	6	2,034			1,053,000	1,053,000
1919			8	8	2,387			1,172,000	1,172,000
1920			11	11	2,597			1,007,000	1,007,000
1921			3	3	464			242,000	242,000
1922			4	4	1,116			462,000	462,000
1923			8	8	2,645			901,377	901,377
1924			6	6	1,872			857,647	857,647
1925			4	4	1,544			881,170	881,170
Total						15,785,900	16,486,635	14,767,894	49,018,829

[1] The catch in Bering Sea for the years 1916 to 1925 has been included with the catch in the North Pacific.

Summary of vessel fishing, 1863 to 1925—Continued

WASHINGTON VESSELS

Years	Number of vessels engaged				Total net tonnage	Number of fish caught			
	Okhotsk Sea	Bering Sea	North Pacific	Total		Okhotsk Sea	Bering Sea	North Pacific	Total
1891		1		1	142		25,000		25,000
1892		2		2	210		163,000		163,000
1893		1		1	142		110,000		110,000
1894		1		1	142		109,000		109,000
1895		1		1	142		112,000		112,000
1896		2		2	508		219,000		219,000
1897		3		3	361		296,000		296,000
1898		1		1	89		50,000		50,000
1899		2		2	286		203,000		203,000
1900		2		2	286		194,000		194,000
1901		1		1	142		85,000		85,000
1902		3		3	368		[2] 296,000		296,000
1903		3	1	4	490		[3] 331,500	95,000	426,500
1904		6		6	599		[4] 484,324		484,324
1905		9		10	1,610		[5] 996,000		996,000
1906		5	3	8	1,425		734,618	280,000	1,014,618
1907		5		5	974		748,430		748,430
1908		7	1	8	1,622		1,008,000	110,000	1,118,000
1909		8		8	1,622		1,148,155		1,148,155
1910		6		6	1,249		911,500		911,500
1911		7		7	1,484		1,103,000		1,103,000
1912		5	1	6	1,251		[6] 550,000	134,000	684,000
1913		5	1	6	1,604		624,260	140,000	764,260
1914		8	1	9	2,482		[7] 1,143,000	209,000	1,352,000
1915		7	1	8	2,084		1,220,571	154,000	1,374,571
1916			9	9	2,317			1,606,400	1,606,400
1917			9	9	2,247			1,323,633	1,323,633
1918			9	9	2,107			1,293,347	1,293,347
1919			6	6	1,619			821,000	821,000
1920			5	5	1,256			550,000	550,000
1921			3	3	658			366,000	366,000
1922			4	4	1,228			680,000	680,000
1923			4	4	1,228			707,000	707,000
1924			5	5	1,448			950,000	950,000
1925			6	6	1,838			1,100,671	1,100,671
Total							12,865,358	11,642,051	23,385,409

ALASKA VESSELS

1916									
1917			3	3	134			42,327	42,327
1918			2	2	25			33,000	33,000
1919			3	3	32			20,537	20,537
1920			8	8	76			123,867	123,867
1921									
1922			2	2	28			19,000	19,000
1923			5	5	90			146,091	146,091
1924			4	4	60			130,560	130,560
1925			4	4	180			74,034	74,034
Total								589,416	589,416

[2] Includes catch by British Columbia schooner Blakeley (144 tons), 107,000 fish.
[3] Includes catch by British Columbia schooner Blakeley (144 tons), 115,000 fish.
[4] Includes catch by British Columbia schooner Blakeley (144 tons), 100,000 fish.
[5] Includes catch by British Columbia schooner Blakeley (144 tons), 78,000 fish.
[6] Includes catch by schooner Albert Meyer (398 tons), British Columbia, 260 fish.
[7] Includes catch by schooner Albert Meyer (398 tons), British Columbia, 100,000 fish.

NOTE.—In addition 6 Alaska vessels, with total net tonnage of 167, caughti n the North Pacific 105,500 fish. These data have been included in the "Recapitulation."

Summary of vessel fishing, 1863 to 1925—Continued

RECAPITULATION

Years	Vessels		Total number of fish caught	Years	Vessels		Total number of fish caught
	Total number	Total net tonnage			Total number	Total net tonnage	
1863	1	120	7,100	1896	8	2,020	837,000
1864	2		54,500	1897	7	1,754	850,000
1865	7	449	225,000	1898	2	866	342,000
1866	18		724,000	1899	7	1,460	783,000
1867	20		943,400	1900	7	1,591	817,000
1868	10	1,502	580,000	1901	7	1,682	787,000
1869	21		1,032,000	1902	12	2,402	1,229,000
1870	22		1,467,000	1903	12	2,389	1,463,800
1871	13		926,000	1904	13	2,538	1,546,524
1872	6		305,500	1905	21	4,538	2,332,133
1873	10		563,000	1906	19	4,662	2,492,618
1874	7		369,000	1907	13	3,374	1,490,230
1875	5	506	362,000	1908	15	3,881	2,028,000
1876	11		814,000	1909	13	3,038	1,748,155
1877	11		779,000	1910	9	2,323	1,291,500
1878	10		902,000	1911	10	2,477	1,542,000
1879	12	1,858	1,301,000	1912	10	2,805	1,348,000
1880	7	1,441	1,002,000	1913	11	3,158	1,481,260
1881	7	1,441	907,000	1914	15	4,265	2,283,202
1882	13	2,260	1,038,000	1915	21	4,426	2,628,071
1883	14	2,837	1,485,000	1916	13	4,012	2,733,400
1884	14	3,222	1,373,000	1917	16	4,076	2,492,960
1885	10	2,287	988,000	1918	17	4,166	2,379,347
1886	8	1,939	800,000	1919	17	4,038	2,013,537
1887	7	1,558	830,000	1920	24	3,929	1,680,867
1888	6	1,391	674,000	1921	6	1,122	608,000
1889	2	623	327,000	1922	10	2,372	1,161,000
1890	3	715	365,000	1923	17	3,963	1,754,468
1891	7	1,374	583,000	1924	15	3,380	1,938,207
1892	7	1,545	775,000	1925	14	3,562	2,055,875
1893	7	1,602	666,000				
1894	6	1,535	698,000	Total			72,706,620
1895	7	1,660	765,000				

DETAILED DATA OF THE FISHING FLEET FROM 1863 TO 1925

The table following shows in detail the operations of the cod-fishing fleet from the inception of the industry in 1863 to 1925, inclusive. The name, rig, and net tonnage of each vessel, the dates of her departure and return, on what ground she fished, and the number of fish taken are all shown.[20] No detailed data are available for 1866 and 1869, while the individual vessel data for 1867 and 1868 are incomplete. From 1863 to 1890, both inclusive, the data relate to California exclusively. Since 1915 vessels fishing on banks off the Alaska coast often fished also on banks in the Bering Sea. The statistics for recent years for these regions, therefore, have been combined under the head "Alaska banks." Owing to the variation in the weight of fish from the various grounds, and also the considerable variation in weight of fish from the same ground in different years, no effort has been made to show the weight of the catch, while the data on the prices realized are so fragmentary that this item also has been omitted, as it would be nothing but a guess at best.

[20] For the data covering the San Francisco fleet from 1870 to 1914, inclusive, the writer is indebted to the Union Fish Co. (formerly the McCollam Fishing & Trading Co.), of San Francisco, which placed its invaluable records at his disposal.

Operations of the cod fleet by years

Name of vessel	Rig	Net tonnage	Date of sailing	Date of return	Fishing grounds	Number of fish taken
1863						
CALIFORNIA [1]						
Timandra [2]	Brig.	120			Okhotsk Sea	7,100
1864						
Timandra	Brig.	120			Okhotsk Sea	50,000
Alert	Sch.				Bering Sea	4,500
Total						54,500
1865						
Equity	Sch.	63			Okhotsk Sea	210,000
Flying Dart	Sch.	84			do	
H. L. Ruggles	Sch.	75			do	
J. D. Sanborn	Sch.	71			do	
Mary Cleveland	Sch.	91			do	
Taccon	Sch.	20			do	
Porpoise	Sch.	45	Mar. 27	July 7	Shumagin Islands [3]	15,000
Total		449				225,000
1867						
Sanborn	Sch.				Shumagin Islands	64,000
Porpoise	Sch.				do	36,000
Sarah Louise	Sch.				do	36,000
Total						136,000
1868						
Porpoise [4]	Sch.				Shumagin Islands	63,000
Mandrago	Sch.				do	85,000
Sanborn	Sch.				do	60,000
Total						208,000
1870						
Clara R. Sutill					Okhotsk Sea	92,000
Constitution	Bkn.	257			do	18,000
Carib					do	92,000
Domingo	Bark.				do	95,000
Florence					do	85,000
Gold Hunter	Bark.				do	125,000
Legal Tender	Bark.				do	125,000
Union					do	100,000
Francisco					do	91,000
Witch Queen					do	62,000
Alaska	Bark.				do	102,000
Shooting Star	Bark.				do	40,000
Arizona					Shumagin Islands	55,000
Ann Eliza					do	20,000
Daisy					do	20,000
J. H. Roscoe	Sch.	79			do	65,000
Mary Zephyr					do	35,000
Porpoise	Sch.				do	38,000
Romp					do	32,000
Sarah Louise	Sch.				do	35,000
Scotland					do	55,000
Wild Gazelle	Sch.	114			do	85,000
Total						1,467,000
1871						
Union					Okhotsk Sea	126,000
Legal Tender	Bark.				do	135,000
Gold Hunter	Bark.				do	125,000
Clara R. Sutill					do	66,000
Domingo	Bark.				do	80,000
Daisy					Shumagin Islands	15,000
Shooting Star					do	35,000
Alaska	Bark.				do	92,000
S. H. Merrill					do	85,000
Flying Mist					do	35,000
Scotland					do	46,000
Alfred Adams	Sch.	64			do	42,000
J. H. Roscoe	Sch.	79			do	44,000
Total						926,000

[1] From 1863 to 1890, inclusive, data relate to California exclusively.
[2] Trading voyage.
[3] First fare from the Shumagins.
[4] Made two trips.

Operations of the cod fleet by years—Continued

Name of vessel	Rig	Net tonnage	Date of sailing	Date of return	Fishing grounds	Number of fish taken
1872						
Gold Hunter	Bark.				Okhotsk Sea	130,000
Scotland					do	
Legal Tender	Bark.				Shumagin Islands	25,000
J. H. Roscoe	Sch.	79			do	58,500
Wild Gazelle	Sch.	114			do	61,000
Flying Mist					do	31,000
Total						305,500
1873						
Gold Hunter	Bark.		Apr. 13		Okhotsk Sea	125,000
Clara R. Sutill			Apr. 26		do	87,000
Page	Sch.	125	Apr. 19		do	76,000
Energy	Bark.		Apr. 10			64,000
Domingo	Bark.		May 15			
Wild Gazelle	Sch.	108	Apr. 19		Shumagin Islands	89,000
Alfred Adams	Sch.	64	Mar. 10		do	40,000
Flying Mist			Mar. 7		do	28,000
Alfred Adams	Sch.	64	July 5		do	30,000
Flying Mist			July 15		do	24,000
Total						563,000
1874						
San Diego	Sch.	36	Apr. 12	July 22	Shumagin Islands	28,000
Energy	Bark.		Apr. 13	Aug. 23	do	80,000
Joseph Wooley	Sch.		Apr. 12	Sept. 5	do	90,000
Alfred Adams	Sch.	64	Apr. 15	Aug. 15	do	56,000
Wild Gazelle	Sch.	114	Apr. 23	Aug. 20	do	78,000
San Diego	Sch.			Oct. 18	do	22,000
Page	Sch.	125		Oct. 11		15,000
Total						369,000
1875						
Undaunted	Sch.	68	Mar. 15		Shumagin Islands	46,000
Alfred Adams	Sch.	64	Mar. 29	Aug. 20	do	56,000
Wild Gazelle	Sch.	108	Apr. 16	Sept. 3	do	93,000
Dashing Wave	Sch.	141	Apr. 18		do	95,000
Page	Sch.	125				72,000
Total		506				362,000
1876						
Alfred Adams	Sch.	64	Jan. 9	July 3	Shumagin Islands	62,000
Alaska	Sch.	32	Mar. 9	July 6	do	28,000
Do			July 19		do	70,000
Selma			Mar. 9	July 1	do	70,000
Page	Sch.	125	Apr. 1	Aug. 19	do	73,000
Energy	Bark.		Aug. 15	do	do	65,000
San Diego	Sch.	36		Aug. 10	do	19,000
Wild Gazelle	Sch.	114	Apr. 12	Sept. 20	do	94,000
Hesperian			Apr. 7	Oct. 11	Okhotsk Sea	150,000
Josephine	Brig.	207	Apr. 12	do	do	130,000
Constitution	Bkn.	257	June 20		do	53,000
Total						814,000
1877						
Page	Sch.	125	Apr. 17	Aug. 17	Okhotsk Sea	62,000
Constitution	Bkn.	257	Apr. 21	Sept. 14	do	133,000
Fremont	Bkn.	345	Apr. 22	do	do	208,000
Brontes			Apr. 25	Lost		
Alaska	Sch	32	Mar. 25	Sept. 11	Shumagin Islands	16,000
J. H. Roscoe	Sch.	79	Apr. 28	Aug. 4	do	61,000
Energy	Bark.		do	Aug. 30	do	70,000
Alfred Adams	Sch.	64	Apr. 4	June 17	do	67,000
Do			June 29	Aug. 25	do	44,000
Wild Gazelle	Sch.	114	Apr. 6	Sept. 4	do	95,000
Pato [5]	Sch.	45	Mar. —		Okhotsk Sea	23,000
Total						779,000

[5] Sailed from Hongkong, China, and landed cargo at Portland, Oreg.; the only cargo of cod ever landed here.

Operations of the cod fleet by years—Continued

Name of vessel	Rig	Net tonnage	Date of sailing	Date of return	Fishing grounds	Number of fish taken
1878						
General Miller	Sch.	108	May 18	Sept. 25	Shumagin Islands	23,000
J. H. Roscoe	Sch.	79	Apr. 9	Aug. 30	do	20,000
May Queen	Sch.		Apr. 3	Aug. 7	do	75,000
Sarah	Sch.	105	Mar. 29	Aug. 24	do	78,000
Three Sisters [6]	Sch.	62			do	35,000
Wild Gazelle	Sch.	114	Apr. 6	Aug. 30	do	20,000
Adelaide Cooper	Bark.	300	Apr. 16	Oct. 2	Okhotsk Sea	216,000
Constitution	Bkn.	257	Apr. 11	Sept. 12	do	140,000
Fremont	Bkn.	345	Apr. 20	Sept. 29	do	250,000
Page	Sch.	125	Apr. 9	Sept. 10	do	45,000
Total						902,000
1879						
Wild Gazelle	Sch.	114	Apr. 2	Sept. 20	Shumagin Islands	85,000
Sarah	Sch.	105	Mar. 16	Aug. 4	do	71,000
Undaunted	Sch.	68	Mar. 15	June 21	do	63,000
H. L. Tiernan	Sch.	145	May 3	Sept. 10	do	97,000
General Miller	Sch.	108	Apr. 3	Sept. 21	do	80,000
Alaska	Sch.	32	Mar. 11	Sept. 10	do	10,000
J. H. Roscoe	Sch.	79	Feb. 28	Aug. 1	do	52,000
Adelaide Cooper	Bark.	300		Sept. 28	Okhotsk Sea	225,000
Fremont	Bkn.	345		Oct. 1	do	240,000
Constitution	Bkn.	257		Sept. 21	do	205,000
Page	Sch.	125	May 13	Oct. 8	do	40,000
Glencoe	Brig.	169		Nov. 7	do	133,000
Total		1,847				1,301,000
1880						
Wild Gazelle	Sch.	114	Apr. 8	Aug. 23	Shumagin Islands	87,000
Arago	Sch.	176	May 2	Sept. 20	Okhotsk Sea	125,000
Page	Sch.	109	May 8	Sept. 4	do	60,000
Glencoe	Brig.	169	May 1	Oct. 28	do	120,000
Fremont	Bkn.	328	May 6	Oct. 10	do	220,000
Constitution	Bkn.	276	May 8	Oct. 28	do	165,000
San Luis	Bkn.	275	May 17	Oct. 4	do	225,000
Total		1,441				1,002,000
1881						
Wild Gazelle	Sch.	114	Apr. 1	Aug. 28	Shumagin Islands	75,000
Page	Sch.	109	Apr. 23	Sept. 12	do	68,000
Arago	Sch.	176	Apr. 27	Sept. 11	Okhotsk Sea	90,000
Constitution	Bkn.	276	do	Oct. 17	do	185,000
Glencoe	Brig.	169	Apr. 29	Oct. 15	do	103,000
Fremont	Bkn.	328	Apr. 30	Sept. 18	do	201,000
San Luis	Bkn.	275	May 6	Oct. 15	do	185,000
Total		1,441				907,000
1882						
Ariel	Sch.	94	Mar. 18	Aug. 18	Shumagin Islands	49,000
Page	Sch.	109	Mar. 20	Aug. 24	do	31,000
General Miller	Sch.	108	do	Lost	do	
H. L. Tiernan	Sch.	142	Apr. 5	Ashore	do	
Dashing Wave	Sch.	141	Apr. 29	Sept. 19	do	60,000
Adrianna	Sch.	95	May 8	July 6	do	54,000
Isabel	Sch.	175	May 12	Sept. 1	Bering Sea	50,000
Tropic Bird	Brig.	172	Apr. 28	Sept. 25	do	82,000
Arago	Sch.	176	Apr. 15	Sept. 28	Okhotsk Sea	111,000
San Luis	Bkn.	275	Apr. 29	Oct. 9	do	185,000
Glencoe	Brig.	169	May 4	Oct. 17	do	72,000
Fremont	Bkn.	328	May 6	Sept. 28	do	204,000
Constitution	Bkn.	276	May 13	Oct. 13	do	140,000
Total		2,260				1,038,000

[6] Lost.

Operations of the cod fleet by years—Continued

Name of vessel	Rig	Net tonnage	Date of sailing	Date of return	Fishing grounds	Number of fish taken
1883						
W. H. Stevens	Sch.	139	Apr. 21	July 27	Shumagin Islands	77,000
Dashing Wave	Sch.	141	May 7	Sept. 21	do	44,000
John Hancock	Sch.	167	Mar. 29	Aug. 22	Bering Sea	75,000
Francis Alice	Sch.	125	do	do	do	60,000
Bonanza	Sch.	128	Apr. 14	do	do	52,000
Tropic Bird	Brig.	172	Mar. 29	do	do	89,000
Isabel	Sch.	175	Apr. 2	Sept. 19	do	105,000
Arago	Sch.	176	Apr. 16	Oct. 5	Okhotsk Sea	96,000
Hera	Sch.	369	Apr. 20	Oct. 19	do	188,000
San Luis	Bkn.	275	Apr. 24	Oct. 15	do	150,000
Constitution	Bkn.	276	do	Oct. 6	do	150,000
Glencoe	Brig.	169	Apr. 25	Oct. 27	do	95,000
Fremont	Bkn.	328	Apr. 28	Sept. 19	do	186,000
Una	Sch.	197	Apr. 30	Oct. 3	do	118,000
Total		2,837				1,485,000
1884						
Dashing Wave	Sch.	141	Mar. 25	Aug. 25	Bering Sea	85,000
John Hancock	Sch.	167	Mar. 23	July 27	do	96,000
Helen W. Almy	Bark.	298	Apr. 2	Sept. 5	do	185,000
Hera	Sch.	369	Apr. 9	Oct. 3	Okhotsk Sea	135,000
Arago	Sch.	176	Apr. 11	Oct. 7	do	80,000
Isabel	Sch.	175	Apr. 13	Oct. 4	do	90,000
W. H. Meyer	Brig.	256	Apr. 18	Oct. 9	do	90,000
Tropic Bird	Brig.	172	Apr. 20	Oct. 6	do	82,000
Jane A. Falkenburg	Bkn.	295	do	Oct. 3	do	136,000
San Luis	Bkn.	275	Apr. 26	do	do	90,000
Constitution	Bkn.	276	do	Oct. 6	do	104,000
Fremont	Bkn.	328	May 2	Oct. 1	do	118,000
Glencoe	Brig.	169	May 5	Oct. 27	do	42,000
Francis Alice	Sch.	125		Oct. 25	do	40,000
Total		3,222				1,373,000
1885						
Arago	Sch.	176	Mar. 27	Sept. 11	Shumagin Islands	50,000
John Hancock	Sch.	167	Apr. 1	Aug. 2	do	64,000
Isabel	Sch.	175	Apr. 18	Aug. 27	do	85,000
Helen W. Almy	Bark.	298	do	Sept. 5	Bering Sea	182,000
Constitution	Bkn.	276	Apr. 22	Oct. 9	Okhotsk Sea	120,000
Tropic Bird	Brig.	172	Apr. 25	Sept. 18	Bering Sea	79,000
Francis Alice	Sch.	125	Apr. 28	Aug. 10	do	35,000
San Luis	Bkn.	275	Apr. 30	Oct. 16	Okhotsk Sea	118,000
Fremont	Bkn.	328	May 2	Oct. 8	do	135,000
Jane A. Falkenburg	Bkn.	295	May 3	Sept. 25	do	120,000
Total		2,287				988,000
1886						
Isabel	Sch.	175	Apr. 1	Aug. 11	Shumagin Islands	92,000
Francis Alice	Sch.	125	Apr. 3	July 15	Bering Sea	69,000
John Hancock	Sch.	167	Apr. 13	Aug. 6	Shumagin Islands	41,000
Helen W. Almy	Bark.	298	do	Sept. 15	Bering Sea	170,000
Fremont	Bkn.	328	Apr. 23	Oct. 4	Okhotsk Sea	141,000
Constitution	Bkn.	276	May 4	Oct. 1	do	84,000
San Luis	Bkn.	275	May 9	Oct. 7	do	102,000
Jane A. Falkenburg	Bkn.	295	May 21	Oct. 5	do	101,000
Total		1,939				800,000
1887						
John Hancock	Sch.	167	Mar. 20	July 12	Shumagin Islands	76,000
Isabel	Sch.	175	Mar. 26	Aug. 25	do	80,000
Dashing Wave	Sch.	141	Apr. 6	Aug. 29	do	79,000
Arago	Sch.	176	Apr. 24	Sept. 4	do	76,000
Constitution	Bkn.	276	Apr. 12	Aug. 12	Bering Sea	185,000
Fremont	Bkn.	328	May 4	Sept. 19	Okhotsk Sea	180,000
Jane A. Falkenburg	Bkn.	295	May 29	Oct. 5	do	151,000
Total		1,558				827,000

Operations of the cod fleet by years—Continued

Name of vessel	Rig	Net tonnage	Date of sailing	Date of return	Fishing grounds	Number of fish taken
1888						
Dashing Wave	Sch.	141	Mar. 16	July 21	Shumagin Islands	69,000
Arago	Sch.	176	Apr. 12	Sept. 2	Bering Sea	103,000
Constitution	Bkn.	276	Apr. 25	Aug. 29	do	191,000
Fremont	Bkn.	328	May 1	Sept. 19	Okhotsk Sea	175,000
Jane A. Falkenburg	Bkn.	295	May 10	Sept. 23	do	136,000
Isabel	Sch.	175		[6]	Shumagin Islands	
Total		1,391				674,000
1889						
Fremont	Bkn.	328	May 6	Sept. 25	Okhotsk Sea	170,000
Jane A. Falkenburg	Sch.	295	May 23	do	do	157,000
Total		623				327,000
1890						
Vanderbilt	Sch.	92	Apr. 13	Aug. 4	Bering Sea	48,000
Jane A. Falkenburg	Sch.	295	May —	Oct. 3	Okhotsk Sea	140,000
Fremont	Bkn.	328	May 17	Oct. 6	do	177,000
Total		715				365,000
1891						
CALIFORNIA						
Francis Alice	Sch.	125	Jan. 11	July 7	Bering Sea	70,000
Dashing Wave	Sch.	141	Mar. 16	Apr. 16[6]		
Arago	Sch.	176	Apr. 16	Aug. 28	Bering Sea	87,000
Jane A. Falkenburg	Sch.	295	Apr. 25	Sept. 1	do	160,000
Fremont	Bkn.	328	May 6	Sept. 23	Okhotsk Sea	171,000
John Hancock	Sch.	167	June 10	Sept. 9	Bering Sea	70,000
Total		1,232				558,000
1891						
WASHINGTON						
Lizzie Colby	Sch.	142			Bering Sea	25,000
1892						
CALIFORNIA						
Arago	Sch.	176	Apr. 10	Aug. 31	Bering Sea	90,000
Jane A. Falkenburg	Sch.	295	Apr. 27	Sept. 12	do	152,000
Fremont	Sch.	328	Apr. 28	Sept. 22	do	175,000
John Hancock	Sch.	167	May 6	Aug. 31	do	70,000
Hera	Sch.	369	May 19	Oct. 11	Okhotsk Sea	125,000
Total		1,335				612,000
WASHINGTON						
Lizzie Colby	Sch.	142	Mar. 17	Aug. 30	Bering Sea	108,000
Moonlight	Sch.	68	Mar. 5	Aug. 20	do	55,000
Total		210				163,000
1893						
CALIFORNIA						
John Hancock	Sch.	167	Feb. 8	Mar. 7[6]		
Francis Alice	Sch.	125	Feb. 24		Shumagin Islands	
Arago	Sch.	176	Apr. 11	Aug. —	Bering Sea	90,000
Jane A. Falkenburg	Sch.	295	Apr. 20	Sept. 9	do	125,000
Hera	Sch.	369	Apr. 22	Sept. 26	Okhotsk Sea	166,000
Fremont	Sch.	328	Apr. 29	Sept. 10	do	175,000
Total		1,460				556,000
WASHINGTON						
Lizzie Colby	Sch.	142			Bering Sea	110,000

[6] Lost.

Operations of the cod fleet by years—Continued

Name of vessel	Rig	Net tonnage	Date of sailing	Date of return	Fishing grounds	Number of fish taken
1894						
CALIFORNIA						
Arago	Sch.	176	Mar. 29	Sept. 6	Bering Sea	90,000
Fremont	Bkn.	328	Mar. 31	Aug. 26	do	180,000
Jane A. Falkenburg	Sch.	295	do	Aug. 27	do	105,000
Hera	Sch.	369	Apr. 19	Sept. 10	Okhotsk Sea	169,000
Uranus	Sch.	225	Apr. 12	Sept. 16	Shumagin Islands and Bering Sea.	45,000
Total		1,393				589,000
WASHINGTON						
Lizzie Colby	Sch.	142			Bering Sea	109,000
1895						
CALIFORNIA						
Fremont	Bkn.	328	Apr. 15	July 18	Bering Sea	159,000
Arago	Sch.	176	Apr. 17	July 20	Okhotsk Sea	89,000
Uranus	Sch.	225	Apr. 21	Aug. 11	Bering Sea	88,000
Jane A. Falkenburg	Sch.	295	Apr. 22	July 19	do	107,000
Hera	Sch.	369	Apr. 25	Sept. 17	Okhotsk Sea	159,000
Francis Alice	Sch.	125			Bering Sea	51,000
Total		1,518				653,000
WASHINGTON						
Lizzie Colby	Sch.	142	Apr. 18	Aug. 9	Bering Sea	112,000
1896						
CALIFORNIA						
Uranus	Sch.	225	Apr. 5	July 23	Bering Sea	81,000
La Ninfa	Sch.	119	Apr. 7	Sept. 2	do	50,000
Jane A. Falkenburg	Sch.	295	Apr. 11	Aug. 3	do	115,000
Fremont	Bkn.	328	Apr. 15	Aug. 5	do	167,000
Arago	Sch.	176	do	July 20	do	80,000
Hera	Sch.	369	Apr. 26	Sept. 9	Okhotsk Sea	125,000
Total		1,512				618,000
WASHINGTON						
Lizzie Colby	Sch.	142			Bering Sea	109,000
Emma F. Harriman [7]	Bark.	366	Apr. 8	Sept. 13	do	110,000
Total		508				219,000
1897						
CALIFORNIA						
Arago	Sch.	176	Mar. 30	July 15	Bering Sea	90,000
Fremont	Bkn.	328	Apr. 2	Sept. 8	do	167,000
Jane A. Falkenburg	Sch.	295	do	Sept. 9	do	124,000
Hera	Sch.	369	Apr. 4	Sept. 13	do	133,000
Uranus	Sch.	225	Apr. 26	Aug. 21	do	40,000
Total		1,393				554,000
WASHINGTON						
Lizzie Colby	Sch.	142			Bering Sea	114,000
Blakeley	Bgn.	144			do	100,000
Swan	Sch.	75			do	55,000
Total		361				269,000

[7] Cargo was taken to San Francisco and sold there.

Operations of the cod fleet by years—Continued

Name of vessel	Rig	Net tonnage	Date of sailing	Date of return	Fishing grounds	Number of fish taken
1898						
CALIFORNIA						
Fremont	Bkn.	328	Apr. 5	Aug. 31	Bering Sea	152,000
Anna	Sch.	227		Oct. 2	do	95,000
Uranus	Sch.	225	May 9	Sept. 22	do	45,000
Total		780				292,000
WASHINGTON						
Lizzie S. Sorrenson	Sch.	89			Bering Sea	50,000
1899						
CALIFORNIA						
Anna	Sch.	227	Mar. 30	Aug. 16	Bering Sea	117,000
Fremont	Bkn.	328	Apr. 1	Sept. 17	do	157,000
Arago	Sch.	176	Apr. 2	Sept. 13	do	80,000
Uranus	Sch.	225	Apr. 5	Aug. 25	do	83,000
Czarina	Sch.	218	Apr. 19	Oct. 1	do	143,000
Total		1,174				580,000
WASHINGTON						
Lizzie Colby	Sch.	142			Bering Sea	93,000
Blakeley	Bkn.	144			do	110,000
Total		286				203,000
1900						
CALIFORNIA						
Stanley	Sch.	253	Apr. 3	Sept. 1	Bering Sea	154,000
Fremont	Bkn.	328	do	Aug. 30	do	160,000
Abbie M. Deering	Sch.	96	Apr. 10	July 1	do	45,000
Anna	Sch.	227	Apr. 9	Aug. 24	do	95,000
Arago	Sch.	176	Apr. 13	Sept. 18	do	80,000
Uranus	Sch.	225	Mar. 26	Sept. 13	do	89,000
Total		1,305				623,000
WASHINGTON						
Lizzie Colby	Sch.	142			Bering Sea	100,000
Blakeley	Bgn.	144			do	94,000
Total		286				194,000
1901						
CALIFORNIA						
Uranus	Sch.	225	Mar. 27	July 7	Bering Sea	53,000
Fremont	Bkn.	328	Apr. 2	Aug. 18	do	177,000
Harrfet G	Brig.	188	Apr. 3	Sept. 7	do	51,000
Stanley	Sch.	253	Apr. 11	Sept. 27	do	195,000
City of Papeete	Bkn.	370	Apr. 13	Sept. 7	do	151,000
Arago	Sch.	176	Apr. 16	Sept. 11	do	75,000
Total		1,540				702,000
WASHINGTON						
Lizzie Colby	Sch.	142			Bering Sea	85,000

Operations of the cod fleet by years—Continued

Name of vessel	Rig	Net tonnage	Date of sailing	Date of return	Fishing grounds	Number of fish taken
1902						
CALIFORNIA						
Stanley	Sch.	253	Mar. 22	Aug. 25	Bering Sea	166,000
Fremont	Bkn.	328	Apr. 1	Aug. 18	do	183,000
Uranus	Sch.	225	do	Aug. 15	do	51,000
Arago	Sch.	176	Apr. 4	Sept. 28	do	72,000
Harriet G	Brig.	188	do	Aug. 26	do	135,000
City of Papeete	Bkn.	370	Apr. 11	Aug. 29	do	217,000
Mary and Ida	Sch.	174	do	Aug. 21	do	102,000
J. G. Wall	Sch.	93	June 15	Sept. 8	do	7,000
Anna [8]	Sch.	227				
Total		2,034				933,000
WASHINGTON						
Lizzie Colby	Sch.	142			Bering Sea	104,000
Carrier Dove	Sch.	82			do	85,000
Total		224				189,000
BRITISH COLUMBIA						
Blakeley	Bgn.	144			Bering Sea	107,000
1903						
CALIFORNIA						
Mary and Ida	Sch.	174	Mar. 20	Aug. 23	Bering Sea	105,000
Arago	Sch.	176	Mar. 22	July 29	do	75,000
Fremont	Bkn.	328	Mar. 28	Sept. 2	do	179,000
Uranus	Sch.	225	Apr. 1	Aug. 21	do	76,300
City of Papeete	Bkn.	370	do	Aug. 12	do	200,000
Harriet G	Brig.	188	Apr. 2	Aug. 29	do	112,000
Emma Claudina	Sch.	185	Apr. 9	do	do	120,000
Stanley	Sch.	253	Apr. 21	Sept. 18	Okhotsk Sea	170,000
Total		1,899				1,037,300
WASHINGTON						
Lizzie Colby	Sch.	142			Bering Sea	84,500
Carrier Dove	Sch.	82			North Pacific [9]	95,000
Nellie Colman	Sch.	122			Bering Sea	132,000
Total		346				311,500
BRITISH COLUMBIA						
Blakeley	Bgn.	144		Sept. 15	Bering Sea	115,000
1904						
CALIFORNIA						
Arago	Sch.	176	Mar. 31	July 13	Shumagin Islands	69,200
Uranus	Sch.	225	do	Sept. 12	Bering Sea	60,000
Harriet G	Brig.	188	do	Sept. 1	do	140,000
Stanley	Sch.	253	Apr. 3	Sept. 10	do	165,000
Fremont	Bkn.	328	Apr. 7	do	do	193,000
City of Papeete	Bkn.	370	Apr. 11	do	do	212,000
Metha Nelson	Sch.	399	May 15	Oct. 11	Okhotsk Sea	223,000
Total		1,939				1,062,200
WASHINGTON						
Lizzie Colby	Sch.	142			Bering Sea	98,000
Alice	Sch.	220			do	128,324
Ida May	Sch.	33			do	14,000
Nellie Colman	Sch.	122		July 27	do	97,000
Carrier Dove	Sch.	82		do	do	47,000
Total		599				384,324
BRITISH COLUMBIA						
Blakeley	Bgn.	144		Sept. —	Bering Sea	100,000

[8] Lost in Bering Sea.

[9] Virtually the same ground as the Shumagin Islands.

Operations of the cod fleet by years—Continued

Name of vessel	Rig	Net tonnage	Date of sailing	Date of return	Fishing grounds	Number of fish taken
1905						
CALIFORNIA						
Zampa	Sch.	322	Mar. 30	Sept. 8	Bering Sea	125,133
Glen	Sch.	121	Apr. 8	Aug. 24	do	65,000
John F. Miller	Sch.	170	Apr. 1	Aug. 25	do	75,000
Harriet G	Sch.	188	Mar. 30	Sept. 3	do	110,000
Stanley	Sch.	253	Mar. 26	Sept. 5	do	135,000
Fremont	Bkn.	328	Mar. 30	Sept. 14	do	190,000
John D. Spreckles	Bkn.	253	May 5	Sept. 29	Okhotsk Sea	133,000
S. N. Castle	Bgn.	464	Apr. 27	Sept. 27	do	210,000
W. H. Dimond	Sch.	376	do	do	do	150,000
City of Papeete	Bkn.	370	do	Oct. 7	do	143,000
Pearl	Sch.	83	(a)		Bering Sea	
Total		2,928				1,336,133
WASHINGTON						
Harold Blekum	Sch.	185	Mar. 13	Aug. 23	Bering Sea	123,000
Ida May	Sch.	33	Apr. 20	July 5	do	10,000
Nellie Colman	Sch.	122	Apr. 18	Aug. 12	do	50,000
Carrier Dove	Sch.	82	Apr. 1	do	do	40,000
Joseph Russ	Sch.	235	Apr. 8	Aug. 31	do	164,000
Alice	Sch.	220	Apr. 1	Aug. 21	do	173,000
Fanny Dutard	Sch.	252	Apr. 15	Sept. 4	do	195,000
Lizzie Colby	Sch.	142	Apr. 10	Aug. 15	do	103,000
Falcon	Sch.	195	May 9	Sept. 1	do	60,000
Total		1,466				918,000
BRITISH COLUMBIA						
Blakeley	Bkn.	144	Apr. 15	Sept. 29	Bering Sea	78,000
1906						
CALIFORNIA						
W. H. Dimond	Sch.	376	Apr. 4	Oct. 3	Okhotsk Sea	140,000
Zampa	Sch.	322	Apr. 9	Oct. 10	Bering Sea	160,000
City of Papeete	Bkn.	370	Apr. 11	do	do	181,000
Fremont	Bkn.	328	Mar. 16	Sept. 9	Okhotsk Sea	159,000
Stanley	Sch.	253	Apr. 4	Sept. 2	Bering Sea	140,000
Harriet G	Brig.	188	Mar. 15	Sept. 4	Okhotsk Sea	141,000
John D. Spreckles	Sch.	253	Mar. 22	do	Bering Sea	80,000
S. N. Castle	Bkn.	464	Apr. 8	Sept. 24	Okhotsk Sea	219,000
Glen	Sch.	121	Mar. 25	Sept. 4	Bering Sea	85,000
Ottillie Fjord	Sch.	247	Mar. 28	Sept. 9	do	140,000
Dora Bluhm	Sch.	315	May 2	Sept. 11	Okhotsk Sea	33,000
Total		3,237				1,478,000
WASHINGTON						
Carrier Dove	Sch.	82	Apr. 3	Sept. 10	North Pacific	48,000
Fanny Dutard	Sch.	252	Apr. 10	Aug. 30	Bering Sea	198,000
Lizzie Colby	Sch.	142	Apr. 14	Aug. 23	do	107,000
Maid of Orleans	Sch.	171	Apr. 24	Sept. 10	North Pacific	120,000
Harold Blekum	Sch.	185	Mar. 10	Aug. 14	do	112,000
Fortuna	Sch.	138	Apr. 18	Aug. 4	Bering Sea	70,000
Joseph Russ	Sch.	235	Mar. 20	Aug. 19	do	197,007
Alice	Sch.	220	Mar. 27	Aug. 17	do	162,611
Total		1,425				1,014,618
1907						
CALIFORNIA						
City of Papeete	Bkn.	370	Apr. 10	Sept. 29	Bering Sea	120,000
Stanley	Sch.	253	Mar. 22	Aug. 31	Okhotsk Sea	140,000
Fremont	Bkn.	328	Apr. 24	Sept. 29	do	108,000
John D. Spreckles	Sch.	253	Apr. 10	July 22	do	5,800
S. N. Castle	Bkn.	464	Apr. 18	July 14	do	18,000
Ottillie Fjord	Sch.	247	Mar. 26	Sept. 14	Bering Sea	135,000
John F. Miller	Sch.	170	Apr. 7	Aug. 29	do	90,000
Dora Bluhm	Sch.	315	Apr. 14	Sept. 20	do	125,000
Total		2,400				741,800

[a] Lost.

Operations of the cod fleet by years—Continued

Name of vessel	Rig	Net tonnage	Date of sailing	Date of return	Fishing grounds	Number of fish taken
1907—Continued						
WASHINGTON						
Fanny Dutard	Sch.	252	Apr. 26	Sept. 16	Bering Sea	180,000
Carrier Dove	Sch.	82	Mar. 20	do	do	98,500
Harold Blekum	Sch.	185	Mar. 19	Aug. 22	do	113,000
Alice	Sch.	220	Apr. 15	Sept. 2	do	165,000
Joseph Russ	Sch.	235	do	Aug. 22	do	191,930
Total		974				748,430
1908						
CALIFORNIA						
W. H. Dimond	Sch.	376	Apr. 9	Oct. 18	Bering Sea	138,000
City of Papeete	Bkn.	370	Mar. 21	Aug. 24	Okhotsk Sea	118,000
Stanley	Sch.	253	Mar. 13	Sept. 16	do	152,000
Fremont	Bkn.	328	Mar. 21	do	do	150,000
Ottillie Fjord	Sch.	247	Mar. 28	Sept. 4	Bering Sea	125,000
Dora Bluhm	Sch.	315	Apr. 18	Oct. 16	do	120,000
City of Papeete	Bkn.	370	Mar. 21	Aug. 24	do	107,000
Total		2,259				910,000
WASHINGTON						
Fanny Dutard	Sch.	252	Apr. 5	Sept. 6	Bering Sea	160,000
Harriet G	Brig.	188	Apr. 18	Sept. 15	do	115,000
Maid of Orleans	Sch.	171	Apr. 15	Aug. 26	do	102,000
Harold Blekum	Sch.	185	Mar. 31	Sept. 3	do	170,000
Vega	Sch.	233	Apr. 5	do	do	102,000
Fortuna	Sch.	138	Apr. 13	Aug. 11	North Pacific	110,000
Alice	Sch.	220	Mar. 28	Aug. 23	Bering Sea	165,000
Joseph Russ	Sch.	235	do	Aug. 24	do	194,000
Total		1,622				1,118,000
1909						
CALIFORNIA						
John D. Spreckles	Sch.	253	Mar. 18	Sept. 8	Bering Sea	115,000
City of Papeete	Bkn.	370	Apr. 15	Sept. 2	do	155,000
Czarina	Sch.	218	Mar. 25	Sept. 8	do	115,000
Ottillie Fjord	Sch.	247	Mar. 28	Sept. 5	do	135,000
Fremont	Bkn.	328	Apr. 14	Oct. 4	Okhotsk Sea	80,000
Total		1,416				600,000
WASHINGTON						
Fanny Dutard	Sch.	252	Apr. 8	Sept. 7	Bering Sea	170,000
Harriet G	Sch.	188	do	Sept. 13	do	122,000
Maid of Orleans	Sch.	171	do	Aug. 20	do	115,000
Harold Blekum	Sch.	185	Mar. 28	Aug. 13	do	110,000
Vega	Sch.	233	Apr. 8	Sept. 7	do	155,000
Fortuna	Sch.	138	Apr. 7	Aug. 16	do	102,000
Alice	Sch.	220	Apr. 8	do	do	170,000
Joseph Russ	Sch.	235	do	Aug. 24	do	204,155
Total		1,622				1,148,155
1910						
CALIFORNIA						
W. H. Dimond	Sch.	376	Mar. 3	Sept. 16	Bering Sea	150,000
City of Papeete	Bkn.	370	Mar. 26	Sept. 15	do	120,000
Fremont	Bkn.	328	Mar. 25	Oct. 1	do	110,000
Total		1,074				380,000
WASHINGTON						
Fanny Dutard	Sch.	252	Apr. 20	Sept. 5	Bering Sea	185,500
Alice	Sch.	220	Apr. 21	Sept. 15	do	175,000
Joseph Russ	Sch.	235	Apr. 17	Sept. 12	do	180,000
Maid of Orleans	Sch.	171	Apr. 15	Aug. 15	do	116,000
Vega	Sch.	233	Apr. 14	Sept. 15	do	150,000
Fortuna	Sch.	138	Apr. 15	Sept. 4	do	105,000
Total		1,249				911,500

Operations of the cod fleet by years—Continued

Name of vessel	Rig	Net tonnage	Date of sailing	Date of return	Fishing grounds	Number of fish taken
1911						
CALIFORNIA						
W. H. Dimond	Sch.	376	Mar. 28	Sept. 6	Bering Sea	176,000
City of Papeete	Bkn.	370	Mar. 25	Aug. 31	do	180,000
Ottillie Fjord	Sch.	247	Mar. 31	Sept. 7	do	83,000
Total		993				439,000
WASHINGTON						
Fanny Dutard	Sch.	252	Apr. 14	Aug. 23	Bering Sea	201,000
Alice	Sch.	220	Mar. 30	Sept. 13	do	170,000
Joseph Russ	Sch.	235	Apr. 1	Aug. 23	do	204,000
John A	Sch.	235	Apr. 20	Sept. 6	do	165,000
Fortuna	Sch.	138	Mar. 31	Aug. 10	do	130,000
Vega	Sch.	233	Apr. 11	Sept. 19	do	165,000
Maid of Orleans	Sch.	171	Apr. 15	Sept. 7	do	68,000
Total		1,484				1,103,000
1912						
CALIFORNIA						
Vega	Sch.	233	Apr. 18	Sept. 17	North Pacific	139,000
W. H. Dimond	Sch.	376	Mar. 25	Aug. 29	Bering Sea	180,000
City of Papeete	Sch.	370	Mar. 28	Aug. 23	do	180,000
Ottillie Fjord	Sch.	247	Mar. 23	Sept. 5	do	75,000
Galilee	Sch.	328	Mar. —	Sept. 19	do	90,000
Total		1,554				664,000
WASHINGTON						
Maid of Orleans	Sch.	171	Apr. 12	Aug. 26	Bering Sea	101,000
Fanny Dutard	Sch.	252	Apr. 10	Aug. 14	do	189,000
Alice	Sch.	220	Apr. 5	Sept. 8	do	171,000
Joseph Russ	Sch.	235	Apr. 7	Apr. 21[6]		
Fortuna	Sch.	138	Apr. 11	Sept. 17	Bering Sea	89,000
John A	Sch.	235	Apr. 12	Sept. 15	North Pacific	134,000
Total		1,251				684,000
1913						
CALIFORNIA						
Galilee	Sch.	328	Mar. 7	Sept. 9	Bering Sea	145,000
Vega	Sch.	233	Feb. 6	Sept. 14	North Pacific	130,000
William H. Dimond	Sch.	376	Mar. 19	Aug. 20	Bering Sea	160,000
City of Papeete	Bkn.	370	Mar. 13	Aug. 27	do	183,000
Ottillie Fjord	Sch.	247	Mar. 18	Aug. 26	do	99,000
Total		1,554				717,000
WASHINGTON						
Maid of Orleans	Sch.	171	Apr. 13	Sept. 10	Bering Sea	105,000
Fanny Dutard	Sch.	252	Apr. 11	do	do	195,000
Alice	Sch.	220	Mar. 27	Sept. 2	do	137,000
John A	Sch.	235	Apr. 5	Sept. 15	North Pacific	140,000
Chas. R. Wilson	Sch.	328	Apr. 2	Sept. 2	Bering Sea	187,000
Total		1,206				764,000
BRITISH COLUMBIA						
Albert Meyer	Sch.	398	Aug. —	Oct. 16	Bering Sea	260

[6] Lost.

Operations of the cod fleet by years—Continued

Name of vessel	Rig	Net tonnage	Date of sailing	Date of return	Fishing grounds	Number of fish taken
1914						
CALIFORNIA						
Sequoia	Sch.	324	Mar. 21	Sept. 9	Bering Sea	152,000
Galilee	Sch.	328	Mar. 24	Sept. 12	do	166,000
Vega	Sch.	233	Mar. 17	Aug. 26	North Pacific	150,000
City of Papeete	Bkn.	370	Mar. 23	Sept. 3	Bering Sea	187,000
Glendale	Sch.	281	do	Sept. 6	do	155,202
Ottillie Fjord	Sch.	247	Mar. 18	Sept. 3	do	121,000
Total		1,783				931,202
WASHINGTON						
Azalea	Sch.	327	Apr. 6	Sept. 11	Bering Sea	212,000
Fanny Dutard	Sch.	252	Apr. 5	Sept. 15	do	172,000
Fortuna	Sch.	138	Apr. 2	Sept. 8	do	96,000
Alice	Sch.	220	Mar. 25	Sept. 15	do	171,000
Wawona	Sch.	413	Apr. 1	Sept. 11	do	240,000
John A	Sch.	235	Apr. 7	Sept. 13	do	100,000
Chas. R. Wilson	Sch.	328	Apr. 2	Sept. 7	North Pacific	209,000
Maid of Orleans	Sch.	171	Apr. 7	Sept. 13	Bering Sea	52,000
Total		2,084				1,252,000
BRITISH COLUMBIA						
Albert Meyer	Sch.	398	Mar. 23	Sept. 9	Bering Sea	100,000
1915						
CALIFORNIA						
Sequoia	Sch.	324	Mar. 16	Aug. 13	Bering Sea	228,500
Galilee	Sch.	328	Mar. 24	Sept. 5	do	195,000
Vega	Sch.	233	Mar. 17	Aug. 26	North Pacific	119,000
Maweema	Sch.	392	Mar. 25	Sept. 7	Bering Sea	235,000
City of Papeete	Sch.	370	Mar. 23	Aug. 19	do	195,000
Glendale	Sch.	281	Mar. 20	Aug. 13	do	161,000
Ottillie Fjord	Sch.	247	Mar. 19	Aug. 27	do	120,000
Total		2,175				1,253,500
WASHINGTON						
Azalea	Sch.	327	Apr. 12	Sept. 6	Bering Sea	206,000
Fanny Dutard	Sch.	252	Apr. 10	Sept. 4	do	188,000
Fortuna	Sch.	138	Mar. 23	Aug. 22	do	110,000
Alice	Sch.	220	Apr. 10	Sept. 6	do	167,248
Wawona	Sch.	413	Apr. 14	Aug. 21	do	258,323
John A	Sch.	235	Apr. 12	Sept. 30	North Pacific	154,000
Chas. R. Wilson	Sch.	328	Apr. 10	Sept. 4	Bering sea	181,000
Maid of Orleans	Sch.	171	Apr. 3	do	do	110,000
Total		2,084				1,374,571
ALASKA						
Highland Queen	Gas. s.	12	(10)		North Pacific	5,000
Challenge	Gas. s.	35			do	12,500
Silver Wave	Gas. s.	19			do	8,000
Miscellaneous power vessels	Gas. s.	101			do	80,000
Total		167				105,500

[10] Wrecked about Apr. 20.

Operations of the cod fleet by years—Continued

Name of vessel	Rig	Net tonnage	Date of sailing	Date of return	Fishing grounds	Number of fish taken
1916						
CALIFORNIA						
City of Papeete	Sch.	370	Apr. 1	Sept. 4	Alaska banks	221,000
Glendale	Sch.	281	Mar. 30	do	do	201,000
Maweema	Sch.	392	Apr. 2	Sept. 8	do	275,000
Sequoia	Sch.	324	Apr. 4	Sept. 2	do	230,000
Galilee	Sch.	328	Apr. 8	Sept. 3	do	220,000
Total		1,695				1,127,000
WASHINGTON						
Azalea	Sch.	327	Apr. 16	Sept. 10	Alaska banks	227,000
Alice	Sch.	220	Mar. 26	Aug. 26	do	172,400
Chas. R. Wilson	Sch.	328	Apr. 7	Aug. 23	do	221,000
Fanny Dutard	Sch.	252	Apr. 16	Aug. 27	do	220,000
Fortuna	Sch.	138	Apr. 18	Sept. 13	do	97,000
John A	Sch.	235	Apr. 16	Sept. 22	do	168,000
Maid of Orleans	Sch.	171	Jan. 11	Sept. 9	do	125,000
Vega	Sch.	233	Apr. 3	Sept. 23	do	105,000
Wawona	Sch.	413	Apr. 4	Aug. 26	do	[11] 271,000
Total		2,317				1,606,400
Grand total		4,012				2,733,400
1917						
CALIFORNIA						
City of Papeete	Sch.	370	Apr. 7	Sept. 4	Alaska Banks	216,000
Galilee	Sch.	328	Apr. 10	Sept. 10	do	220,000
Glendale	Sch.	281	Apr. 8	Sept. 4	do	182,000
Maweema	Sch.	392	Apr. 14	Sept. 6	do	255,000
S. N. Castle	Sch.	464	Apr. 17	Sept. 5	do	103,000
Sequoia	Sch.	324	Apr. 7	Sept. 4	do	258,000
Vega	Sch.	233	Apr. 10	Sept. 3	do	118,000
Total		2,392				1,352,000
WASHINGTON						
Progress	Gas. s.	115	Mar. 3	July 10	Alaska banks	63,155
Do			Aug. 5	Nov. 25	do	12,000
Azalea	Sch.	327	Apr. 2	Sept. 17	do	216,000
Alice	Sch.	220	do	Sept. 2	do	154,478
Chas. R. Wilson	Sch.	328	Apr. 7	Aug. 28	do	185,000
Fanny Dutard	Sch.	252	May 1	Sept. 17	do	148,000
Harold Blekum	Sch.	185	Jan. 20	[12]		
John A	Sch.	235	Apr. 16	Sept. 16	Alaska banks	178,000
Maid of Orleans	Sch.	172	Jan. 10	Sept. 19	do	103,000
Wawona	Sch.	413	Apr. 10	Sept. 13	do	264,000
Total		2,247				1,323,633
ALASKA						
Chas. Brown	Sch.	64			Alaska banks	
Valdez	Gas. s.	10			do	
Hunter	Gas. s.	60			do	
Total		134				42,327
Grand total		4,773				2,717,960

[11] Catch landed at San Francisco.

[12] Wrecked Mar. 3.

Operations of the cod fleet by years—Continued

Name of vessel	Rig	Net tonnage	Date of sailing	Date of return	Fishing grounds	Number of fish taken
1918						
CALIFORNIA						
City of Papeete	Sch.	370	Apr. 9	Aug. 27	Alaska banks	194,000
Glendale	Sch.	281	do	Sept. 2	do	178,000
Maweema	Sch.	392	Apr. 18	Sept. 22	do	207,000
Sequoia	Sch.	324	do	Aug. 18	do	180,000
Beulah	Sch.	339	Apr. 25	Sept. 17	do	154,000
Louise	Sch.	328	do	Oct. 7	do	140,000
Total		2,034				1,053,000
WASHINGTON						
Azalea	Sch.	237	Apr. 22	Sept. 22	Alaska banks	192,000
Alice	Sch.	220	Apr. 15	Sept. 8	do	120,657
John A	Sch.	235	Apr. 29	Sept. 17	do	141,000
Chas. R. Wilson	Sch.	328	Apr. 20	Sept. 6	do	165,000
Galilee	Sch.	328	Apr. 26[13]	Sept. 25	do	170,000
Maid of Orleans	Sch.	171	Apr. 20	Sept. 6	do	111,000
Wawona	Sch.	413	Apr. 22	Sept. 7	do	244,459
Progress	Gas.	115	Feb. 8	Sept. 29	do	125,000
Chas. Brown	Sch.	60			do	24,231
Total		2,107				1,293,347
ALASKA						
Alice	Gas. s.	15				18,000
Valdez	Gas. s.	10				15,000
Total		25				33,000
Grand total		4,166				2,379,347
1919						
CALIFORNIA						
City of Papeete	Sch.	370	Apr. 1	Sept. 1	Alaska banks	179,000
Glendale	Sch.	281	May 3	do	do	133,000
Maweema	Sch.	392	Apr. 7	do	do	217,000
Sequoia	Sch.	324	Mar. 30	Sept. 2	do	128,000
Galilee	Sch.	328	Apr. 3	Sept. 6	do	150,000
Louise	Sch.	328	Apr. 17	Sept. 17	do	145,000
Beulah	Sch.	339	Apr. 10	Sept. 8	do	200,000
America	Sch.	25			do	20,000
Total		2,387				1,172,000
WASHINGTON						
Fanny Dutard	Sch.	252	May 13	Sept. 14	Alaska banks	120,000
John A	Sch.	235	May 1	Sept. 12	do	150,000
Chas. R. Wilson	Sch.	328	May 13	Sept. 12	do	105,000
Maid of Orleans	Sch.	171	Apr. 16	Aug. 24	do	81,000
Alice	Sch.	220	Apr. 3	Sept. 9	do	132,000
Wawona	Sch.	413	Apr. 23	Sept. 11	do	233,000
Total		1,619				821,000
ALASKA						
Alice	Gas. s.	15			Alaska banks	
Flossie	Gas. s.	10			do	
Edith	Gas. s.	7			do	
Total		32				20,537
Grand total		4,038				2,013,537

[13] Sailed from San Francisco but landed catch on Puget Sound.

Operations of the cod fleet by years—Continued

Name of vessel	Rig	Net tonnage	Date of sailing	Date of return	Fishing grounds	Number of fish taken
1920						
CALIFORNIA						
City of Papeete	Sch.	370	Apr. 8	Aug. 27	Alaska banks	145,000
Maweema	Sch.	392	Apr. 11	Sept. 4	do	204,000
Glendale	Sch.	281	Apr. 15	do	do	116,000
Sequoia	Sch.	324	Mar. 28	Aug. 27	do	160,000
Galilee	Sch.	328	Apr. 6	Aug. 12	do	76,000
Louise	Sch.	328	Apr. 12	Aug. 27	do	145,000
Beulah	Sch.	339	Apr. 15	Aug. 24	do	72,000
Progress	Gas.	115		do	do	23,000
Charles Brown	Sch.	64		Sept. 15	do	27,000
Eunice	Gas.	35			do	21,000
Mary G	Gas.	21			do	18,000
Total		2,597				1,007,000
WASHINGTON						
Maid of Orleans	Sch.	171	Apr. 17	Sept. 14	Alaska banks	86,000
John A	Sch.	235	Apr. 20	Sept. 7	do	102,000
Wawona	Sch.	413	Apr. 15	Sept. 6	do	174,000
Alice	Sch.	220	Apr. 20	Sept. 12	do	103,000
Dora	S. s.	217	May 19	Aug. 20	do	85,000
Total		1,256				550,000
ALASKA						
Lister	Gas.	14				
Pilgrim	Gas.	5				
Northern King	Gas.	7				
Patmos	Gas.	16			Alaska banks	123,867
Edith	Gas.	7				
Buffalo	Gas.	17				
Nimrod	Gas.	5				
North Star	Gas.	5				
Total		76				123,867
Grand total		3,929				1,680,867
1921						
CALIFORNIA						
Louise	Sch.	328	May 5	Sept. 4	Alaska banks	194,000
Progress	Gas.	115			do	30,000
Mary G	Gas.	21			do	18,000
Total		464				242,000
WASHINGTON						
Maid of Orleans	Sch.	171	Apr. 23	Aug. 22	Alaska banks	105,000
John A	Sch.	235	Apr. 24	Aug. 29	do	103,000
Fanny Dutard	Sch.	252	May 10	Aug. 28	do	158,000
Total		658				366,000
Grand total		1,122				608,000
1922						
CALIFORNIA						
Louise	Sch.	328	Apr. 2	Sept. 16	Alaska banks	180,000
Progress	Gas.	115			do	25,000
Glendale	Sch.	281	Mar. 25	Aug. 10	do	150,000
Maweema	Sch.	392	Apr. 1	Sept. 1	do	107,000
Total		1,116				462,000
WASHINGTON						
John A	Sch.	235	Apr. 20	Sept. 11	Alaska banks	160,000
Chas. R. Wilson	Sch.	328	Apr. 19	do	do	164,000
Wawona	Sch.	413	Apr. 18	Aug. 27	do	183,000
Fanny Dutard	Sch.	252	Apr. 25	Sept. 17	do	173,000
Total		1,228				680,000

Operations of the cod fleet by years—Continued

Name of vessel	Rig	Net tonnage	Date of sailing	Date of return	Fishing grounds	Number of fish taken
1922—Continued						
ALASKA						
Northern King	Gas.	7			Alaska banks	9,000
Mary G	Gas.	21			do	10,000
Total		28				19,000
Grand total		2,372				1,161,000
1923						
CALIFORNIA						
Louise	Sch.	328	May 13	Sept. 17	Alaska banks	40,000
Beulah	Sch.	328	Apr. 29	do	do	156,000
Galilee	Sch.	339	Mar. 14	Aug. 25	do	189,377
Progress	Gas.	115			do	21,000
Maweema	Sch.	392	Apr. 15	Sept. 27	do	310,000
Glendale	Sch.	281	Apr. 8	Sept. 16	do	185,000
Bangor	Sch.	398			do	
S. N. Castle	Sch.	464			do	
Total		2,645				901,377
WASHINGTON						
Fanny Dutard	Sch.	252	Apr. 18	Sept. 11	Alaska banks	171,000
Wawona	Sch.	413	Apr. 11	Sept. 7	do	168,000
John A	Sch.	235	Apr. 10	Aug. 29	do	163,000
Chas. R. Wilson	Sch.	328	Apr. 8	Sept. 11	do	205,000
Total		1,228				707,000
ALASKA						
Brant	Gas.	8			Alaska banks	8,000
Hillside II	Gas.	28			do	6,961
San Jose	Gas.	14			do	43,000
Plover	Gas.	19			do	73,130
Mary G	Gas.	21			do	15,000
Total		90				146,091
Grand total		3,963				1,754,468
1924						
CALIFORNIA						
Maweema	Sch.	392	Apr. 2	Sept. 14	Alaska banks	170,000
City of Papeete	Sch.	370	Mar. 9	Sept. 5	do	220,000
Louise	Sch.	328	Feb. 16	Aug. 31	do	149,783
Galilee	Sch.	339	Mar. 18	Sept. 10	do	142,000
Beulah	Sch.	328	Mar. 21	Aug. 30	do	144,864
Progress	Gas.	115			do	31,000
Total		1,872				857,647
WASHINGTON						
John A	Sch.	235	Apr. 12	Aug. 25	Alaska banks	177,000
Chas. R. Wilson	Sch.	328	Apr. 14	Aug. 26	do	232,000
Fanny Dutard	Sch.	252	Apr. 24	Aug. 28	do	181,000
Alice	Sch.	220	Apr. 14	Aug. 25	do	135,000
Wawona	Sch.	413	Apr. 15	Aug. 17	do	225,000
Total		1,448				950,000
ALASKA						
Daisy	Gas.	18			Alaska banks	3,500
Brant	Gas.	9			do	7,020
San Jose	Gas.	14			do	65,000
Plover	Gas.	19			do	55,040
Total		60				130,560
Grand total		3,380				1,938,207

Operations of the cod fleet by years—Continued

Name of vessel	Rig	Net tonnage	Date of sailing	Date of return	Fishing grounds	Number of fish taken
1925						
CALIFORNIA						
Maweema	Sch.	392	Apr. 4	Aug. 25	Alaska banks	194,000
Wm. H. Smith	Sch.	496	Feb. 23	Aug. 29	do	283,653
Galilee	Sch.	328	Mar. 5	Sept. 2	do	180,776
Louise	Sch.	328	Mar. 27	Aug. 29	do	222,741
Total		1,544				881,170
WASHINGTON						
Chas. R. Wilson	Sch.	328	Apr. 7	Aug. 22	Alaska banks	237,674
John A	Sch.	235	Apr. 8	Aug. 28	do	156,327
C. A. Thayer	Sch.	390	Apr. 26	Sept. 18	do	256,160
Fanny Dutard	Sch.	252	Apr. 22	Aug. 22	do	83,000
Alice	Sch.	220	Apr. 10	Aug. 19	do	138,268
Wawona	Sch.	413	do	Aug. 22	do	229,242
Total		1,838				1,100,671
ALASKA						
Progress	Gas.	115			Alaska banks	
Pirate	Gas.	30			do	
Mary G	Gas.	21			do	
San Jose	Gas.	14			do	
Total		180				74,034
Grand total		3,562				2,055,875

SUMMARY OF THE SHORE-STATION DATA

The following table shows, in a condensed form, the data relating to the vessels plying to and from the Alaska shore stations and the fish brought from thence to the home stations. These transporting vessels usually make several trips each year, and in some instances fishing vessels are utilized for this purpose when not engaged in fishing. The total fish transported represent the catches made at the various shore stations.

Summary of shore-station data

Year	Number of vessels	Net tonnage	Number of trips	Number of cod brought to California	Number of cod brought to Washington [1]	Total number from shore stations
1876	1	114	1	30,000		30,000
1877	1	114	1	101,000		101,000
1878	3	190	6	227,000		227,000
1879	1	64	4	198,000		198,000
1880	2	172	4	201,000		201,000
1881	1	64	3	154,000		154,000
1882	1	108	3	203,000		203,000
1883	2	245	4	235,000		235,000
1884	1	137	3	249,000		249,000
1885	2	278	4	386,000		386,000
1886	3	454	5	383,000		383,000
1887	1	137	3	299,000		299,000
1888	2	285	4	372,000		372,000
1889	4	823	7	489,000		489,000
1890	4	621	9	773,000		773,000
1891	4	624	7	662,000		662,000
1892	2	388	4	700,000		700,000

[1] Nearly all of the cod brought to Washington came on regular steamers, and the same is true of a small part of those brought to California.

Summary of shore-station data—Continued

Year	Number of vessels	Net tonnage	Number of trips	Number of cod brought to California	Number of cod brought to Washington	Total number from shore stations
1893	2	366	4	660,000		660,000
1894	1	218	2	305,000		305,000
1895	1	218	2	286,000		286,000
1896	1	125	1			No report.
1897	4	652	6	511,000		511,000
1898	6	930	9	450,000		450,000
1899	6	975	11	722,000		722,000
1900	5	898	9	909,000		909,000
1901	5	907	8	727,000		727,000
1902	6	1,080	11	1,140,000		1,140,000
1903	4	631	11	985,000		985,000
1904	6	1,100	10	959,000	43,000	1,002,000
1905	6	1,384	10	1,274,000	[2] 8,000	1,282,000
1906	11	2,117	15	890,632	130,000	1,020,632
1907	7	1,153	14	[3] 1,116,951	402,000	1,518,951
1908	9	2,281	12	994,403	152,000	1,146,403
1909	8	2,134	9	897,361	[4] 13,000	910,361
1910	3	724	7	680,600	[4] 2,875	683,475
1911	7	1,836	9	909,000	[5] 83,000	992,000
1912	4	1,040	7	960,984	[6] 36,950	997,934
1913	6	1,397	6	[6] 657,847	[6] 146,250	804,097
1914	6	1,465	11	1,481,000	[6] 104,600	1,585,600
1915	3	719	7	1,114,400	30,100	1,144,500
1916	4	1,187	6	1,014,500	144,607	1,159,107
1917	3	859	6	1,205,000	143,000	1,348,000
1918	3	859	5	825,268	621,142	1,446,410
1919	5	1,468	5	1,177,000	419,802	1,596,802
1920	6	2,098	6	1,224,000	701,182	1,925,182
1921	7	1,889	7	1,123,000	519,000	1,642,000
1922	2	593	3	648,000	190,300	838,300
1923	3	623	5	926,000	244,375	1,170,375
1924	3	504	3	545,000	301,650	846,650
1925	4	989	5	808,000	91,924	899,924
Total				33,788,946	4,528,757	38,317,703

[2] Schooner Nellie Colman, from Seattle, lost with 30 lives.
[3] Schooner Glen, from San Francisco, lost with 28,000 fish.
[4] Shipped on regular steamship lines.
[5] Eight thousand of these were shipped on regular steamers.
[6] Schooner John D. Spreckles, of San Francisco, lost with 145,000 cod aboard.

DETAILED OPERATIONS OF THE TRANSPORTING FLEET FROM 1876 TO 1925

The following table shows in detail the cod shipped from the shore fishing stations in Alaska from 1876, when the first station was established, to 1925, both inclusive. The name, rig, and tonnage of the transporting vessel is shown, together with the dates of departure from and arrival at the home station, also the number of cod brought.[21] From 1876 to 1903, both inclusive, the data relate exclusively to California.

[21] For the early data relating to the fleet of transporters owned and operated from San Francisco the writer is indebted to the very complete and accurate records kept by the Union Fish Co. (formerly the McCollam Fishing & Trading Co.), of San Francisco.

Operations of the transporting fleet by years

Name of vessel	Rig	Net tonnage	Date of sailing	Date of return	Number of fish brought
1876					
CALIFORNIA [1]					
Wild Gazelle	Sch.	114	Oct. 18	----------	30,000
1877					
Wild Gazelle	Sch.	114	Sept. 24	Nov. 18	101,000
1878					
Alaska	Sch.	32	Mar. 18	June 15	22,000
Do			June 24	Sept. 15	12,000
Alfred Adams	Sch.	64	Apr. 4	June 22	51,000
Do			July 9	Aug. 29	46,000
Do			Sept. 10	Nov. 9	51,000
Ariel	Sch.	94	----------	June 25	45,000
Total					227,000
1879					
Alfred Adams	Sch.	64	Mar. 12	Apr. 25	56,000
Do			May 13	June 29	57,000
Do			July 11	Aug. 25	45,000
Do			Sept. 2	Oct. 14	40,000
Total					198,000
1880					
Alfred Adams	Sch.	64	Mar. 16	May 8	42,000
Do			May 17	June 25	52,000
Do			July 3	Aug. 16	45,000
Wild Gazelle	Sch.	108	Sept. 11	Oct. 23	62,000
Total					201,000
1881					
Alfred Adams	Sch.	64	Mar. 21	May 31	52,000
Do			June 7	July 19	51,000
Do			July 26	Sept. 18	51,000
Total					154,000
1882					
Wild Gazelle	Sch.	108	Mar. 18	May 16	60,000
Do			June 2	July 28	83,000
Do			Aug. 12	Oct. 2	60,000
Total					203,000
1883					
Wild Gazelle	Sch.	108	Mar. 20	June 14	85,000
Do			June 21	Aug. 3	90,000
Do			Aug. 15	[2]	----------
Czar	Sch.	137	Oct. 3	Nov. 10	60,000
Total					235,000
1884					
Czar	Sch.	137	Mar. 23	June 14	102,000
Do			June 25	Aug. 14	97,000
Do			Sept. 16	Nov. 5	50,000
Total					249,000
1885					
Czar	Sch.	137	Mar. 12	Apr. 20	68,000
Do			May 8	June 30	120,000
Do			July 19	Sept. 19	98,000
Dashing Wave	Sch.	141	Apr. 1	June 11	100,000
Total					386,000

[1] From 1876 to 1903, inclusive, the data relate to California exclusively.
[2] Lost Aug. 19.

Operations of the transporting fleet by years—Continued

Name of vessel	Rig	Net tonnage	Date of sailing	Date of return	Number of fish brought
1886					
Arago	Sch.	176	Jan. 7	Sept. 18	60,000
Dashing Wave	Sch.	141	Mar. 14	May 30	58,000
Czar	Sch.	137	Apr. 1–4	May 24	99,000
Do			June 13	Aug. 10	101,000
Do			Aug. 28	Oct. 10	65,000
Total					383,000
1887					
Czar	Sch.	137	Apr. 2	May 20	125,000
Do			June 11	Aug. 7	99,000
Do			Aug. 25	Oct. 15	75,000
Total					299,000
1888					
Czar	Sch.	137	Mar. 12	May 14	131,000
Do			June 3	Aug. 8	115,000
Do			Aug. 26	Oct. 31	55,000
Eliza Miller	Sch.	148	Aug. 30	Oct. 25	71,000
Total					372,000
1889					
Czar	Sch.	137	Feb. 11	Apr. 6	132,000
Do			May 2	June 25	127,000
Do			July 10	Sept. 1	66,000
Dashing Wave	Sch.	141	Mar. 21	June 28	95,000
Do			July 12	Oct. 8	
Arago	Sch.	176	Apr. 5	Aug. 21	65,000
Hera	Sch.	369			4,000
Total					489,000
1890					
Czar	Sch.	137	Feb. 10	Apr. 7	115,000
Do			Apr. 19	June 17	117,000
Do			June 29	Aug. 30	103,000
Do			Sept. 13	Nov. 12	45,000
Dashing Wave	Sch.	141	Mar. 12	May 26	80,000
Do			June 15	July 26	80,000
Do				Oct. 22	70,000
John Hancock	Sch.	167	Mar. 16	Aug. 19	45,000
Arago	Sch.	176	Mar. 22	Aug. 12	118,000
Total					773,000
1891					
John Hancock	Sch.	167	Jan. 7	May 31	85,000
Czar	Sch.	137	Feb. 12	Apr. 21	110,000
Do			May 5	July 3	122,000
Do			July 15	Sept. 1	130,000
Do			Sept. 13	Nov. 13	75,000
Blakeley	Bgn.	144	May 30	Aug. 21	90,000
Arago	Sch.	176	Sept. 10	Nov. 8	50,000
Total					662,000
1892					
Czarina	Sch.	218	Jan. 30	Apr. 17	210,000
Do			May 14	July 11	240,000
Do			Aug. 18	Oct. 31	100,000
John F. Miller	Sch.	170	Apr. 30	June 28	150,000
Total					700,000
1893					
Czarina	Sch.	218	Feb. 3	Apr. 28	240,000
Do			May 18	July 18	215,000
Do			Aug. 19	Oct. 27	75,000
Eliza Miller	Sch.	148	May 14		130,000
Total					660,000

Operations of the transporting fleet by years—Continued

Name of vessel	Rig	Net tonnage	Date of sailing	Date of return	Number of fish brought
1894					
Czarina	Sch.	218	Apr. 5	June 28	190,000
Do			Aug. 4	Oct. 10	115,000
Total					305,000
1895					
Czarina	Sch.	218	Mar. 7	May 18	126,000
Do			Aug. 4	Oct. 18	160,000
Total					286,000
1896					
Francis Alice	Sch.	125	Aug. 28		[3]
1897					
Eliza Miller	Sch.	148	Jan. 4	Feb. 17	77,000
Czarina	Sch.	218	Sept. 12 [4]	Apr. 26	118,000
Mary and Ida	Sch.	174	May 7	Sept. 9	90,000
Winchester	Sch.	112	May 25	Sept. 3	47,000
Czarina	Sch.	218	June 23	Sept. 8	144,000
Mary and Ida	Sch.	174	Feb. 4	Apr. 27	35,000
Total					511,000
1898					
Czarina	Sch.	218	Sept. 30 [5]	Mar. 7	17,000
Winchester	Sch.	112	Sept. 20 [5]	Mar. 10	101,000
Do			Mar. 24	June 17	30,000
Czarina	Sch.	218	Apr. 7	Sept. 7	118,000
Arago	Sch.	176	Oct. 3 [5]	Apr. 10	26,000
Francis Alice	Sch.	125		June 11	52,000
Mary and Ida	Sch.	174	Aug. —	Sept. 27	47,000
Francis Alice	Sch.	125	Sept. 29	Dec. 16	28,000
Winchester	Sch.	112	June 26	Oct. 31	31,000
Total					450,000
1899					
Winchester	Sch.	112	Jan. 3	Mar. 9	40,000
Arago	Sch.	176	Aug. 2 [6]	Jan. 20	25,000
Francis Alice	Sch.	125	Dec. 29 [6]	Feb. 25	61,000
Do			Mar. 11	June 5	78,000
Winchester	Sch.	112	Mar. 17	May 19	63,000
Czarina	Sch.	218	Sept. 28 [6]	Apr. 3	71,000
John F. Miller	Sch.	170	May 5	July 5	79,000
Winchester	Sch.	112	June 4	Aug. 1	36,000
Mary and Ida	Sch.	174	Oct. 30 [6]	July 28	75,000
Do			Aug. 25	Dec. 12	129,000
Francis Alice	Sch.	125	Oct. 21	Dec. 20	65,000
Total					722,000
1900					
Anna	Sch.	227	Jan. 6	Mar. 27	90,000
Czarina	Sch.	218	Jan. 17	Mar. 23	170,000
Mary and Ida	Sch.	174	Mar. 19	Aug. 2	106,000
Arago	Sch.	176	Oct. 12 [7]	Mar. 27	35,000
Czarina	Sch.	218	Apr. 11	June 28	192,000
Winchester	Sch.	112	Oct. 1 [7]	May 10	55,000
Do			May 23	Aug. 8	57,000
Czarina	Sch.	218	July 22	Oct. 20	123,000
Mary and Ida	Sch.	174	Aug. 21	Nov. 14	81,000
Total					909,000
1901					
Arago	Sch.	176	Oct 9 [8]	Mar. 21	31,000
Mary and Ida	Sch.	174	Mar. 24	Aug. 27	95,000
Winchester	Sch.	112	Apr. 7	June 26	85,000
Czarina	Sch.	218	Nov. 3 [8]	Apr. 15	165,000
Anna	Sch.	227	Nov. 21 [8]	[9]	
Czarina	Sch.	218	May 6	July 13	206,000
Winchester	Sch.	112	July 13	Sept. 15	85,000
Do			Oct. 8	Nov. 23	60,000
Total					727,000

[3] Catch not reported.
[4] 1896.
[5] 1897.
[6] 1898.
[7] 1899.
[8] 1900.
[9] Lost Company Harbor, Sannak Island, Mar. 3, 1901.

Operations of the transporting fleet by years—Continued

Name of vessel	Rig	Net tonnage	Date of sailing	Date of return	Number of fish brought
1902					
Mary and Ida	Sch.	174	Sept. 29[10]	Jan. 14	16,000
Pearl	Sch.	120	Feb. 2	May 15	60,000
Czarina	Sch.	218	Oct. 6[10]	Feb. 16	167,000
Arago	Sch.	176	Oct. 26[10]	Mar. 10	45,000
Czarina	Sch.	218	Mar. 16	May 29	208,000
Mary and Ida	Sch.	174	Feb. 5	Mar. 20	125,000
Pearl	Sch.	120	May 24	July 9	60,000
Czarina	Sch.	218	June 20	Aug. 25	208,000
Stanley	Sch.	253	Sept. 14	Nov. 11	112,000
Mary and Ida	Sch.	174	Sept. 16	Nov. 28	48,000
Viking	Sch.	139	----------	Aug. 1	91,000
Total					1,140,000
1903					
Pearl	Sch.	120	Dec. 7[11]	Jan. 28	18,000
Czarina	Sch.	218	Jan. 28	Mar. 30	135,000
Pearl	Sch.	120	Feb. 12	Mar. 26	22,000
Volante	Sch.	119	Mar. 10	June 6	150,000
Pearl	Sch.	120	Apr. 9	May 28	68,000
Czarina	Sch.	218	Apr. 12	July 18	192,000
Pearl	Sch.	120	June 5	July 26	66,000
Do	----------	----------	Aug. 11	Oct. 6	54,000
Czarina	Sch.	218	---do----	Nov. 9	180,000
Pearl	Sch.	120	Oct. 26	Dec. 28	30,000
Mary and Ida	Sch.	174	Sept. 30	Dec. 24	70,000
Total					985,000
1904					
CALIFORNIA					
Czarina	Sch.	218	Jan. 17	Mar. 24	144,000
Mary and Ida	Sch.	174	---do----	[12]	----------
Pearl	Sch.	120	Jan. 19	Mar. 24	55,000
John D. Spreckles	Sch.	253	Apr. 10	June 22	146,000
Pearl	Sch.	120	---do----	Aug. 10	38,000
Czarina	Sch.	218	Apr. 11	June 23	204,000
Do	----------	----------	July 22	Oct. 3	180,000
Pearl	Sch.	120	Sept. 27	Nov. 18	30,000
John D. Spreckles	Sch.	253	Aug. 11	Nov. 26	162,000
Total					959,000
WASHINGTON					
Carrier Dove	Sch.	82	----------	Feb. 20	43,000
1905					
CALIFORNIA					
Czarina	Sch.	218	Jan. 16	Mar. 19	125,000
Do	----------	----------	Apr. 1	July 18	163,000
Do	----------	----------	Aug. 17	Nov. 5	144,000
Annie Larsen	Sch.	326	Apr. 5	June 10	252,000
Stanley	Sch.	253	Oct. 23[13]	Jan. 29	205,000
Do	----------	----------	Oct. 10	----------	----------
John D. Spreckles	Sch.	253	Oct. 24	Dec. 1	----------
W. H. Dimond	Sch.	376	Jan. 18	Mar. 22	150,000
Zampa	Sch.	322	Oct. 12	----------	----------
Marion	Sch.	223	Apr. 1	June 18	145,000
Do	----------	----------	July 18	Sept. 24	90,000
John F. Miller	Sch.	170	Oct. 7	----------	----------
Glen	Sch.	121	Sept. 19	----------	----------
Total					1,274,000
WASHINGTON					
From Kodiak	----------	----------	July 10	Oct. 12	8,000
Nellie Colman	Sch.	122	Oct. 1	[14]	----------

[10] 1901.
[11] 1902.
[12] Lost on Unga Island Feb. 23, 1904; had 78,000 fish aboard.
[13] 1904.
[14] Wrecked.

Operations of the transporting fleet by years—Continued

Name of vessel	Rig	Net tonnage	Date of sailing	Date of return	Number of fish brought
1906					
CALIFORNIA					
Marion	Sch.	223	[15]	Mar. 12	20,000
Do			Mar. 19	[16]	
Czarina	Sch.	218	Feb. 26	July 19	153,349
Do			Aug. 13	Oct. 29	98,000
Stanley	Sch.	253	Oct. 10[17]	Mar. 10	63,000
Alpha	Sch.	274	Mar. 12	June 10	244,283
John F. Miller	Sch.	170	Oct. 7[17]	Mar. 17	25,000
Do			Apr. 8	July 5	84,000
Do			July 29	Sept. 30	40,000
Glen	Sch.	121	Sept. 19[17]	Mar. 8	5,000
Dora Bluhm	Sch.	315	May 2	Sept. 11	33,000
Newport	S. S.	149	July 4	Aug. 19	125,000
Total					890,632
WASHINGTON					
Maid of Orleans	Sch.	171		March	10,000
Ralph J. Long	Sch.	85	June 23	July 5	100,000
Fortuna	Sch.	138	[18]	Apr. 5	20,000
Total					130,000
1907					
CALIFORNIA					
W. H. Dimond	Sch.	376	Dec. —[18]	Jan. 18	103,000
Do			Mar. 20	June 4	292,000
Do			June 21	Oct. 2	60,000
Do			Oct. 31		
Hunter	Sch.	60	Sept. 20[18]	Sept. 30	50,000
Czarina	Sch.	218	Jan. 24	Mar. 27	130,000
Do			Apr. 20	July 19	177,665
Do			Aug. 22	Nov. 9	174,286
Rosie H	Sch.	69	[15]	June 27	45,000
Glen	Sch.	121	Apr. 13	June 10	85,000
Do			Aug. 25	[19]	
Total					1,116,951
WASHINGTON					
Maid of Orleans	Sch.	171	Apr. 2	July 30	98,000
Do			Aug. 29		169,000
Fortuna	Sch.	138	Mar. 15	May 15	40,000
Do			May 27	Oct. 1	95,000
Total					402,000
1908					
CALIFORNIA					
W. H. Dimond	Sch.	376	Jan. 28	Mar. 22	80,000
John D. Spreckles	Sch.	253	Mar. 13	June 20	205,000
Do			July 23	Oct. 19	80,000
Repeat	Sch.	410	Apr. 18	July 9	In ballast
City of Papeete	Bkn.	370	Oct. 9		
Czarina	Sch.	218	Dec. 12[20]	Mar. 7	92,903
Do			Apr. 2	July 11	186,500
Ivy	Sch.	135	Mar. 19	May 15	100,000
Ida McKay	Sch.	178	Apr. 6	June 18	150,000
Do			July 11	Sept. 22	100,000
John F. Miller	Sch.	170	Nov. 23[20]	[21]	
Total					994,403
WASHINGTON					
Maid of Orleans	Sch.	171		Mar. 8	65,000
Do			Sept. 24	Nov. 22	87,000
Total					152,000

[15] Wintered in the North.
[16] Lost Apr. 11, 1906.
[17] 1905.
[18] 1906.
[19] Lost Sept. 30, with 28,000 fish.
[20] 1907.
[21] Wrecked Jan. 8, 1908.

Operations of the transporting fleet by years—Continued

Name of vessel	Rig	Net tonnage	Date of sailing	Date of return	Number of fish brought
1909					
CALIFORNIA					
City of Papeete	Bkn.	370	Sept. 3	Oct. 29	155,000
John D. Spreckles	Sch.	253	Dec. 5[22]	Feb. 21	44,000
W. H. Dimond	Sch.	376	Mar. 15	May 12	105,000
Czarina	Sch.	218	Oct. 9[22]	Feb. 25	125,000
Stanley	Sch.	253	Apr. 26	June 25	272,361
Ida McKay	Sch.	178	Mar. 30	June 14	65,000
Dora Bluhm	Sch.	315	----------	July 8	85,000
Do			----------	Sept. 26	16,000
San Buena Ventura	Sch.	171	----------	Nov. —	30,000
Total					897,361
WASHINGTON					
Regular steamers			[23]	[23]	13,000
1910					
CALIFORNIA					
John D. Spreckles	Sch.	253	Nov.10[24]	Mar. 9	90,000
Do			Mar. 25	May 31	90,000
Do			June 13	Oct. 3	130,000
Stanley	Sch.	253	Oct.17[24]	[25]	----------
Czarina	Sch.	218	June 13	Aug. 16	120,600
Do			Apr. 7	May 31	160,000
Do			Oct. 7	Nov. 24	90,000
Total					680,600
WASHINGTON					
Regular steamers			[23]	[23]	2,875
1911					
CALIFORNIA					
John D. Spreckles	Sch.	253	Oct.31[26]	Mar. 17	131,000
Do			Apr. 9	June 20	169,000
Do			July 16	Sept. 25	103,000
City of Papeete	Bkn.	370	Oct. 4	Dec. 7	55,000
Galilee	Sch.	328	May 20	July 27	251,000
Czarina	Sch.	218	Jan. 15	[27]	----------
Sequoia	Sch.	324	Aug. 14	Oct. 10	200,000
Ottillie Fjord	Sch.	247	Sept. 25	Dec. 8	----------
Total					909,000
WASHINGTON					
Bender Bros	Sch.	96	Apr. 20	June 6	75,000
Regular steamers			[23]	[23]	8,000
Total					83,000
1912					
CALIFORNIA					
Vega	Sch.	233	Oct.20[28]	Jan. 17	152,000
Sequoia	Sch.	324	Mar. 31	July 1	276,984
John D. Spreckles	Sch.	253	Apr. 7	Apr. 27	150,000
Bertha Dolbeer	Sch.	230	Apr. 6	June 27	30,000
John D. Spreckles	Sch.	253	May 29	Aug. 29	135,000
Sequoia	Sch.	324	July 27	Oct. 6	210,000
Bertha Dolbeer	Sch.	230	----------	Nov. 17	7,000
Total					960,984
WASHINGTON					
Regular steamers			[23]	[23]	36,950

[22] 1908.
[23] Various dates.
[24] 1909.
[25] Wrecked Mar. 28, 1910.
[26] 1910.
[27] Lost Feb. 15, 1910.
[28] 1911.

Operations of the transporting fleet by years—Continued

Name of vessel	Rig	Net tonnage	Date of sailing	Date of return	Number of fish brought
1913					
CALIFORNIA					
Galilee	Sch.[29]	328	Nov. 11[29]	Jan. 11	190,847
Sequoia	Sch.	324	Mar. 29	May 30	240,000
Golden State	Sch.	223	Aug. 15	Oct. 13	175,000
John D. Spreckles	Sch.	253	Jan. 25	[30]	
Bertha Dolbeer	Sch.	230	Mar. 8	July 28	52,000
Total					657,847
WASHINGTON					
Union Jack	Sch.	39		Oct. 29	20,000
Regular steamers			[23]	[23]	126,250
Total					146,250
1914					
CALIFORNIA[31]					
City of Papeete	Bktn.	370	Oct. 8[31]	Jan. 25	200,000
Do			Oct. 18	Dec. 21	45,000
Golden State	Sch.	223	Nov. 15[31]	Jan. 15	159,000
Do			Mar. 5	Apr. 20	199,420
Do			May 20	Aug. 4	194,000
Do			Oct. 15	Dec. 20	171,000
W. H. Dimond	Sch.	376	Jan. 9	Jan. 28[32]	
Allen A	Sch.	266	Mar. 3	May 27	240,000
Do			June 20	Nov. 2	200,000
Bertha Dolbeer	Sch.	230	Mar. 10	May 27	32,000
Do			July 18	Oct. 1	41,000
Total					1,481,420
WASHINGTON					
Independent stations, regular steamers			[23]	[23]	104,600
1915					
CALIFORNIA					
Golden State	Gas. s.	223	Feb. 21	Apr. 12	174,000
Do			May 6	July 1	230,000
Do			Oct. 19	Dec. 15	170,000
Allen A	Sch.	266	Feb. 18	June 2	267,400
Do			June 18	Aug. 15	193,000
Do			Sept. 6	Dec. 22	47,000
Bertha Dolbeer	Sch.	230	Mar. 13	June 2	33,000
Total					1,114,400
WASHINGTON					
Regular steamers			[23]	[23]	30,100
1916					
CALIFORNIA					
Golden State	Gas. s.	223	Jan. 18	Mar. 5	198,000
Do			Mar. 29	June 25	201,000
Do			July 26	Sept. 24	155,000
Galilee	Sch.	328	Oct. 29	Dec. 21	134,500
Allen A	Sch.	266	Jan. —	May 9	178,000
Do			May 28	Oct. 23	148,000
City of Papeete	Sch.	370	Oct. 29		
Total					1,014,500
WASHINGTON					
Regular steamers			[23]	[23]	144,607

[23] Various dates.
[29] 1912.
[30] Lost; had 145,000 fish aboard; all lost.
[31] 1913.
[32] Lost.

Operations of the transporting fleet by years—Continued

Name of vessel	Rig	Net tonnage	Date of sailing	Date of return	Number of fish brought
1917					
CALIFORNIA					
City of Papeete	Sch.	370	Oct. 29[33]	Jan. 3	160,000
Do			Oct. 25		
Allen A	Sch.	266	Mar. 21	July 8	288,000
Do			Aug. 22	Nov. 13	168,000
Golden State	Gas. s.	223	Mar. 10	May 15	227,000
Do			June 10	July 31	177,000
Do			Aug. 26	Oct. 30	185,000
Total					1,205,000
WASHINGTON					
Regular steamers			[23]	[23]	143,000
1918					
CALIFORNIA					
City of Papeete	Sch.	370	Oct. 25[34]	Feb. 14	26,000
Do			Oct. 18		
Allen A	Sch.	266	Feb. 15	May 17	223,000
Do			June 21	Sept. 22	195,000
Do			Oct. 30		
Golden State	Gas. s.	223	Mar. 5	May 7	172,000
Do			May 26	July 22	209,268
Do			Oct. 24		
Total					825,268
WASHINGTON					
Regular steamers			[23]	[23]	621,142
1919					
CALIFORNIA					
City of Papeete	Sch.	370	Oct. 18[35]	Mar. 6	206,000
Allen A [36]	Sch.	266	Oct. 30[36]		
Maweema	Sch.	392	Oct. 4		
Golden State	Gas. s.	223	Oct. 24[36]	Jan. 1	165,000
Do			Feb. 13	Apr. 23	165,000
Do			May 8	July 27	216,000
Do			Oct. 12	Oct. 25	200,000
Regular steamers			[23]	[23]	225,000
Total					1,177,000
WASHINGTON					
Dora	S. s.	217	Apr. 20	Sept. 5	65,000
Regular steamers			[23]	[23]	354,802
Total					419,808
1920					
CALIFORNIA					
Maweema	Sch.	392	Oct. 4[37]	Jan. 3	235,000
City of Papeete	Sch.	370	Oct. 13[37]	Jan. 29	235,000
S. N. Castle	Sch.	464	Feb. 29	June 5	186,000
Sequoia	Sch.	324	Aug. 28[37]	Jan. 2	256,000
Carolyn Frances	Sch.	325	Mar. 6	June 9	190,000
Golden State	Gas. s.	223	Jan. 20	Mar. 23	100,000
Do			Nov. 16		
By steamer			[23]	[23]	22,000
Total					1,224,000
WASHINGTON					
By steamers			[23]	[23]	701,182

[23] Various dates.
[33] 1916.
[34] 1917.
[35] 1918.
[36] Wrecked Apr. 3, 1919.
[37] 1919.

Operations of the transporting fleet by years—Continued

Name of vessel	Rig	Net tonnage	Date of sailing	Date of return	Number of fish brought
1921					
CALIFORNIA					
Maweema	Sch.	392	Mar. 21	June 17	336,000
City of Papeete	Sch.	370	July 23	Oct. 17	232,000
Golden State	Gas. s.	223	Nov. 16[38]	Feb. 24	235,000
Sequoia	Sch.	324	Apr. 16	July 23	210,000
Oregon	Gas. s.	269	----------	Nov. 9	110,000
Total					1,123,000
WASHINGTON					
Oregon	Gas. s.	269	----------	July 31	260,000
Iskum	-------	42	----------	Dec. 1	25,000
By steamers	-------	-------	[23]	[23]	234,000
Total					519,000
1922					
CALIFORNIA					
City of Papeete	Sch.	370	Mar. 26	Aug. 27	220,000
Golden State	Gas. s.	223	Nov. 11[39]	Feb. 1	200,000
Do	-------	-------	Mar. 23	May 25	228,000
Total					648,000
WASHINGTON					
By steamers	-------	-------	[23]	[23]	190,300
1923					
CALIFORNIA					
City of Papeete	Sch.	370	Mar. 23	Aug. 13	190,000
Golden State	Gas. s.	223	Feb. 18	Apr. 17	200,000
Do	-------	-------	May 18	July 14	193,000
Do	-------	-------	Aug. 11	Oct. 6	221,000
Pirate	Gas. s.	30	----------	Sept. 29	122,000
Total					926,000
WASHINGTON					
By steamers	-------	-------	[23]	[23]	244,375
1924					
CALIFORNIA					
Glendale	Sch.	281	Sept. 17	Jan. 3[40]	156,000
Golden State	Gas. s.	223	Feb. 9	Sept. 12	209,000
Glendale	Sch	281	----------	Oct. 7	180,000
Total					545,000
WASHINGTON					
By steamers	-------	-------	[23]	[23]	301,650
1925					
CALIFORNIA					
Glendale	Sch.	281	Feb. 20	Aug. 14	156,000
Golden State	Gas. s.	223	Feb. 17	Apr. 10	193,000
Do	-------	-------	May 1	Aug. 30	250,000
City of Papeete	Sch.	370	May 26	Sept. 20	194,000
Progress	Gas. s.	115	[24]	Aug. 27	15,000
Total		989			808,000
WASHINGTON					
By steamers	-------	-------	[23]	[23]	91,924

[23] Various dates.
[24] 1909.
[38] 1920.
[39] 1921
[40] 1925.

DISASTERS TO THE FLEET

Operating as it does in far northern waters, where the dangers to navigation are numerous and the waters are very poorly surveyed and charted, it is a matter for congratulation that so few disasters have been recorded as occurring to the fleet. The following table, which is not claimed to be complete, shows the total wrecks of which it was possible to find a record. No account is taken of the many minor accidents to the fleet, of partial disablements, groundings, etc., some of which proved very costly to the owners, however.

Record of wrecks of codfish vessels from 1877 to 1925, inclusive

Name [1]	Owner and home port	Where wrecked	Date	Lives lost	Codfish lost
Brontes	——, San Francisco		1877		
Sarah	Lynde & Hough, San Francisco.		1879		
Nagay [2]	McCollam & Co., Alaska	Popof Island	Summer, 1880		
General Miller	N. Bichard, San Francisco		1882		
H. L. Tiernan	Lynde & Hough, San Francisco.	Shumagin Islands	1882		
Wild Gazelle	McCollam & Co., San Francisco.		Aug. 19, 1883		
Isabel	Hansen & Anderson, San Francisco.	Foundered at sea	1888	14	
Dashing Wave	Lynde & Hough, San Francisco.	Bering Sea	Apr. 16, 1891		
John Hancock	do		Mar. 7, 1893		
Anna	Alaska Codfish Co., San Francisco.	Bering Sea	1902		
Mary and Ida	do	Unga Island	Feb. 23, 1904		78,000
Pearl	do		1905	30	
Nellie Colman	Seattle & Alaska Codfish Co., Seattle.	At sea	1905	30	
Pirate [2]	Union Fish Co., Alaska	Alaska	1906		
Marion	Alaska Codfish Co., San Francisco.	Sannak Island	Apr. 11, 1906		
Glen	Pacific States Trading Co., San Francisco.	Unimak Island	Sept. 30, 1907	1	28,000
John F. Miller	do	do	Jan. 8, 1908	[3] 10	
Stanley	Union Fish Co., San Francisco.	Sannak Island	Mar. 28, 1910	4	
Czarina	do	Nagai Island	Feb. 15, 1911		
Joseph Russ	Robinson Fisheries Co., Anacortes, Wash.	Chirikof Island	Apr. 21, 1912	1	
John D. Spreckles	Alaska Codfish Co., San Francisco.	Run down off California coast.	Mar. 29, 1913	2	145,000
W. H. Dimond	do	Bird Island	Feb. 3, 1914		
Nonpariel [2]	do	Shumagin Islands	1915		
Highland Queen		do	About Apr. 20		
Harold Blekum	Northern Fisheries Co., Anacortes, Wash.	Ugak Bay, Kodiak Island.	Mar. 3, 1917		
Hunter	do	Off Sutwik Island	Aug. 30, 1917		[4]
Allen A. [5]	Alaska Codfish Co., San Francisco.	Unga Island	Apr. 3, 1919		
Dora	Bering Sea Fisheries Co., Seattle.	Hardy Bay, Vancouver Island, B. C.	Dec. 20, 1920		

[1] All schooner rigged, except the Nonpariel, which was a power schooner, and the Dora, which was a steamer.
[2] Employed in station work.
[3] All frozen to death.
[4] Total cargo.
[5] Was subsequently hauled off and towed to Seattle for repairs, and finally sold

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The following bibliography of the cod fisheries of the Pacific coast is not intended to be a complete list of the works and articles on this subject, but does include virtually all that contain anything of

value relating to the commercial phases of it. The Pacific Fisherman, of Seattle, Wash., contains many short articles and notes relating to the industry, only a few of the more important of which have been listed. The newspapers of San Francisco, Calif., and Seattle and Anacortes, Wash., also contain a number of references to the industry.

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REFRIGERATION OF FISH [1]

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[1] Appendix VIII to the Report of the U. S. Commissioner of Fisheries for 1926. Bureau of Fisheries Document No. 1016. Technological contribution No. 29.

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INTRODUCTION

Cold is the nearest approach to an ideal preservative that we have. It has been employed from the most ancient times for preserving foods, jars of milk and butter in cool spring water, meats exposed to outside temperatures in winter, and melons and fruits in cool caves and cellers being ancient examples; but it was only with the development of machinery for producing and controlling cold artificially, beginning in the latter part of the last century, that cold was applied systematically and in a large way to the preservation of perishable foods. During the greater part of the time since the first practical ice machine was invented, attention and scientific study have been concentrated on the perfection of mechanical means of producing cold rather than on the best methods of utilizing cold to preserve various classes of foods. This order of progress is natural and logical, but the time has arrived when study is being directed more specifically to the best methods of applying cold to keep the various kinds of perishable commodities. The aim of this paper is to present and discuss the application of refrigeration to fish and sea foods as a special class in which sufficient progress has been made in recent years to justify such a presentation.

FUNCTION OF REFRIGERATION IN THE FISH INDUSTRY

Before artificial refrigeration was used as a method of preserving fish they were dried, salted, or pickled, and later were canned; but fish preserved by any of these methods are greatly changed and are suitable for special purposes only. They do not at all meet the demands for fresh fish. Refrigeration is the only method of preserving that keeps fish in essentially its original condition over long periods and during transportation over long distances.

Perhaps few who are not directly connected with the fish industry fully realize the importance of refrigeration in the distribution of fish to the consumer. Fish are highly perishable; yet if there were a regular and dependable supply, and if the demand for fish were also steady and continuous, there would be little need for artificial refrigeration. But both supply and and demand are highly irregular. Nearly all fishes are migratory; they have their seasons of abundance and scarcity; weather influences the capture and chance plays an important part in locating the schools of fish. Many fishes, like the mackerel, may be taken in diminishing numbers from year to year, and then, all of a sudden, appear in tremendous abundance, choking the market and demoralizing prices.

The demand for fish also is subject to marked fluctuations because of social, racial, and sectarian customs. In summer, when fish are generally abundant and the weather is fair, the popular demand declines and fish move much more slowly in the markets than they do in winter. In the Lenten season often more fish are demanded than

can be obtained from the local supply. Friday has become, by long custom, the fish day of the week. The causes that influence fluctuations in demand bear no relation whatever to the causes that control the supply. Under such circumstances refrigeration is absolutely necessary in order that the industry may meet the demand with the available supply without ruinous waste.

It is natural that when fish are present in abundance the fisherman will catch all he can. If hundreds of other fishermen are doing the same thing (as they must to earn their living), the market may be glutted, and but for refrigeration it would be necessary to dump edible fish because of a lack of market. Refrigeration is thus an agency of conservation of no little importance.

POPULAR OBJECTIONS TO FROZEN FISH

Little need be said here of the widespread suspicion of frozen or cold-storage fish if special pleading is to be avoided. In so far as these objections are based on impaired edible quality, pleadings are of no avail—the grounds for objection must be removed. Many refinements and improvements already have been introduced in the art, other improvements are known and will be put into practice, and research may be expected further to advance and perfect the art. If this treatise hastens the introduction of improvements, it will serve well its purpose.

EFFECT OF REFRIGERATION ON THE PRICES OF FISH

There is also a popular conception—or, perhaps, misconception—that refrigeration raises the price of fish unfairly. If this were true, the immense refrigeration industry would rest on an unsound economic basis. After all, the price of fish, like that of other commodities, is fixed by the interaction of supply and demand. Refrigeration increases neither supply nor demand. Without it prices would be disastrously low in glutted markets and exorbitantly high in seasons of scarcity. Refrigeration serves to spread the supply over the year at a comparatively uniform price. If the year's supply exceeds the year's demand, prices drop. Fish that otherwise would be dumped are saved. The cost of refrigeration is undoubtedly a proper charge for a valuable service rendered.[2]

HISTORY OF REFRIGERATION OF FISH[3]

Until the early part of last century, when ice came into use, refrigeration was not applied to the preservation of fish in any systematic way. In northern latitudes fish were allowed to freeze naturally in winter and were transported frozen to market. Fresh fish were kept as cool as possible with wet seaweed. Between 1820 and 1850 natural ice came into use, and transportation facilities were developed. The cooling of fish with ice began in 1838 at Gloucester, Mass., when a

[2] For data and discussion of the economics of cold storage see G. K. Holmes, Cold Storage Business Features, Bulletin 93, and Cold Storage and Prices, Bulletin 101, U. S. Department of Agriculture, Washington.

[3] For an account of the history of the refrigeration of fish up to 1900 see Modern Refrigeration of Food and Drinks—Refrigeration of Fish. Ice and Refrigeration, Vol. XXI, 1901, pp. 91–94, Chicago. Also, Preservation of Fishery Products for Food, by Chas H. Stevenson. Bulletin, United States Fish Commission, Vol. XVIII, 1898 (1899), pp. 335–563. Washington.

halibut smack first carried ice. The practice came into more general use in 1845. At first the ice was kept in a corner of the hold, separate from the fish, because of a prejudice against iced fish. Eventually it was found that ice in contact did not materially affect the fish, which were thenceforth packed in ice. Because of the prejudice against iced fish (such as we now encounter against frozen fish) iced packages were not shipped until 1858, when New England dealers shipped iced fish as an experiment to New York City; the practice rapidly grew, and a large trade was quickly developed.

Enoch Piper [4], of Camden, Me., was first to freeze fish artificially. He laid out the fish in racks in an insulated chamber and set pans of crushed ice and salt mixture on them, which froze the fish in about 24 hours. The frozen fish, after being glazed by a dip in cold water, were transferred to an insulated chamber provided with vertical metallic tubes filled with the freezing mixture to keep the fish frozen until used. He improved his process in a patent of 1862.[5]

In 1866 and 1867 Charles F. Pike,[6] of Providence, R. I., applied similar principles to refrigeration aboard ship.

The method of freezing fish in cakes, by packing them in pans or molds to be placed in freezing chambers, was originated by David W. and Samuel H. Davis,[7] of Detroit, Mich. In the earlier form of the invention the pans were truncated cones of such size and shape as to make a series of cakes just to fit a barrel in which the frozen fish were shipped. In 1880 D. W. Davis [8] patented a method of packing fish in finely crushed ice in a barrel and subjecting the entire barrel to refrigeration to freeze the contents to a solid mass. D. W. Davis's work culminated in 1902 [9] in the invention of a process of freezing in a rectangular pan, the pan being covered with a lid, packed in an ice-and-salt mixture for freezing, the frozen cake removed with the aid of water, glazed in cold water, and stored. Aside from the freezing in ice and salt this is essentially the method in widespread use to-day.

In 1876 Robert C. Armstrong [10] patented a shipping package consisting of a small barrel inside a larger one, with sawdust between the two, and an outlet pipe. Fish and ice were put in the smaller barrel and the whole was headed for shipment.

Numerous other patents and improvements came forth in the eighties and nineties, relating to various methods of freezing, the discussion of which will fall more logically in this paper in the sections devoted to special processes of freezing and will be treated elsewhere. Meanwhile, the most important step in the artificial refrigeration of fish was the introduction of refrigerating machines using ammonia, which came into use for freezing and storing fish in 1892 at Sandusky, Ohio. Since that time, and particularly since the beginning of the present century, the method of freezing fish in cold rooms has come into widespread use.

In 1879 winter-frozen salmon were first shipped to England by Sir Charles Petrie, but for lack of suitable storage facilities in

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[4] U. S. Patent 31736, Mar. 19, 1861.
[5] U. S. Patent 36107, Aug. 5, 1862.
[6] U. S. Patent 72894, Dec. 31, 1867.
[7] U. S. Patent 161596, Apr. 6, 1875.
[8] U. S. Patent 226390, Apr. 13, 1880.
[9] U. S. Patent 709751, Sept. 23, 1902.
[10] U. S. Patent 178094, May 30, 1876.

that country the venture was not successful. By 1888 fish were frozen in large quantities at Astrakhan, Russia, and numerous warehouses were opened in various European cities for this trade. In 1894 artificially frozen steelhead salmon were first shipped from Vancouver, British Columbia, to England. In the following year close upon 6,000,000 pounds of salmon, halibut, and sturgeon were frozen in British Columbia, and more than 1,000,000 pounds were shipped to Europe, principally to Hamburg. In this same year, Sir Charles Petrie began his importations of Loggie salmon into England.

By the beginning of the present century the fish-freezing industry was well established, since which time it has expanded to a large business, conducted in various parts of the world, reaching its highest development in the United States and Canada. Immense warehouses are now filled with frozen fish, large cargoes cross the ocean, and highly elaborate and expensive machinery is built to furnish the refrigeration. The art of freezing and transporting fish has been refined by engineers, chemists, and practical men until it is now an industry of which we may well be proud.

In 1889 two Englishmen, Hesketh and Marcet,[11] patented the process of freezing meat, fish, etc., which consists of immersing them in cold brine or inclosing them in hollow-walled cells, with cold brine circulating in the walls. In the same year two other Englishmen—Douglas and Donald[12]—patented the freezing of foods by inclosing them in bags, immersing them in water, and freezing. Nothing came of these inventions at the time, but the idea was revived later by numerous inventors. It was upon the discovery several years ago that rapid freezing produces frozen fish of much better quality, that serious and widespread attention was given to these and similar methods. Numerous patents have been issued and several of the newer methods are in practical application. These will be considered more fully later.

STATISTICS OF FISH FROZEN IN THE UNITED STATES

The amount of fish frozen annually in the United States comes close upon 100,000,000 pounds. The year 1924 was the record year, with 97,324,144 pounds frozen. In 1925 the total was 91,165,068 pounds. Of this amount 54.95 per cent were six varieties—ciscoes, halibut, the salmons, lake trout, mackerel, and whiting. The remainder is made up largely of squid, the pikes and pike perches, shellfish, whitefish, and butterfish. Receipts at the warehouses begin to exceed the withdrawals in May, and from then until November the holdings rapidly increase, particularly from July to November. In November, 1925, 61,849,359 pounds were in storage. Withdrawals exceed receipts from November to April. In the latter month in 1925 holdings had been reduced to 22,441,873 pounds from the holdings in November, 1924, which were 70,405,786 pounds. When allowance is made for the fish frozen during that period, amounting to 22,309,214 pounds, there is shown a withdrawal of 70,273,127 pounds in the five months from November 15, 1924, to April 15, 1925. In 1925, between April 15 and November 15, 70,686,243 pounds were frozen and 31,278,757 pounds were withdrawn. The average hold-

[11] British patent 6117, Apr. 9, 1889. [12] British patent 20614, Dec. 23, 1889.

ings for the year were 44,084,251 pounds. It is impossible to determine from the available statistics the average term of storage.

NUMBER AND LOCATION OF COLD-STORAGE WAREHOUSES THAT HANDLE FISH

According to such information as is available, there are in the United States 169 warehouses that handle frozen fish. Of this number 102 handle only fish while 67 handle fish and other goods. Many of these are private warehouses, several of them do a public business, and some of them combine a public and private business. The distribution of these warehouses is shown in Table 1.

TABLE 1.—*Cold storage warehouses that handle fish in the United States*

State, Territory, or district	Number of warehouses			State, Territory, or district	Number of warehouses		
	Fish only	Fish and other goods	Total		Fish only	Fish and other goods	Tota
Alaska	3		3	Mississippi	1		1
California	4	6	10	Nebraska	1	1	2
Colorado	1	1	2	New Jersey	1	3	4
Florida	2	1	3	New York	12	8	20
Georgia	1		1	Ohio	17	4	21
Illinois	1	4	5	Oklahoma	1		1
Iowa	1	1	2	Oregon	6	1	7
Kentucky		1	1	Pennsylvania	8	7	15
Louisiana		1	1	Rhode Island		1	1
Maine	4	1	5	Tennessee	2	1	3
Maryland		2	2	Virginia		3	3
Massachusetts	11	6	17	Washington	5	6	11
Michigan	8		8	Wisconsin	7	1	8
Minnesota	1	4	5				
Missouri	4	3	7	Total	102	67	169

GEOGRAPHICAL DISTRIBUTION OF THE FISH-FREEZING BUSINESS

The region of the United States where the largest amount of fish is frozen is the Pacific coast, including Alaska, where 31.12 per cent of the total was frozen in 1925. The New England States, with 26.94 per cent of the total, appear in the statistics as next in volume of fish frozen. In 1924 the Middle Atlantic States occupied second place, largely because of the ciscoes frozen in New York and Pennsylvania where these States border on the Great Lakes; but because of a large decrease in the amount of ciscoes frozen in 1925 this region fell behind in that year. The North Central divisions, east and west, which include the Great Lakes region (except those parts of New York and Pennsylvania already referred to), together account for 18.79 per cent of the total in 1925.

It is significant that the South Atlantic and Gulf States freeze only the negligible quantity of a little more than 1 per cent of the total. The southern Pacific region also freezes very little, the amount not being shown separately.

In Canada the distribution of the industry is similar to that in the United States. In British Columbia there are large freezers whose business is chiefly in salmon, halibut, and black cod. Along the Great Lakes whitefish, lake trout, and ciscoes make up the bulk, while in the eastern Provinces salmon, eels, herring, and smelts constitute the greater part of the frozen fish.

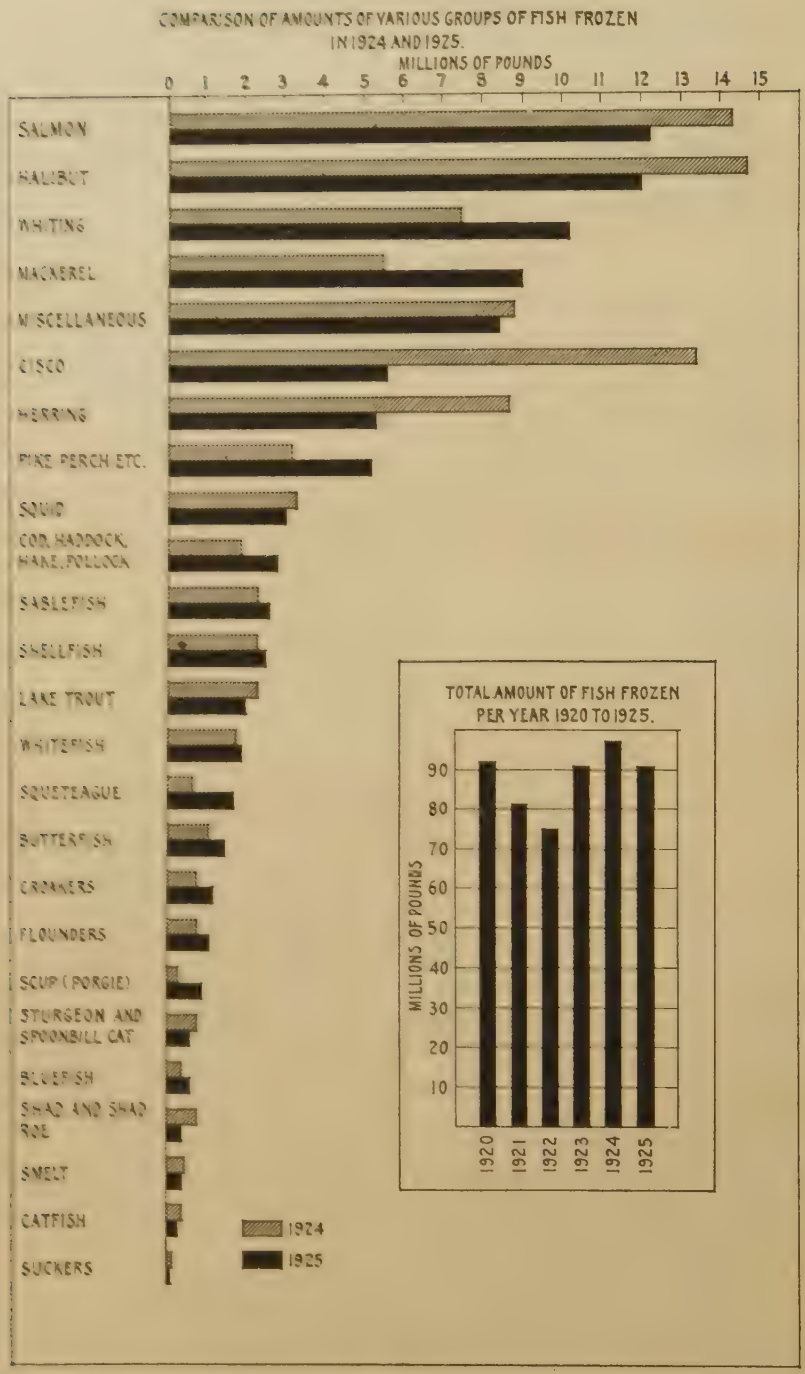
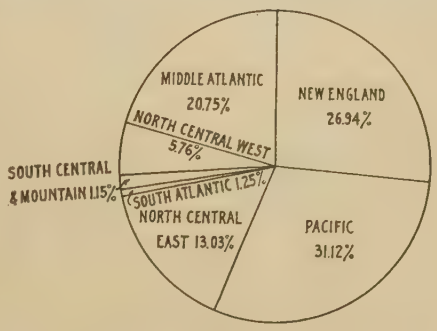

COMPARISON OF AMOUNTS OF VARIOUS GROUPS OF FISH FROZEN IN 1924 AND 1925.
MILLIONS OF POUNDS
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
SALMON
HALIBUT
WHITING
MACKEREL
MISCELLANEOUS
CISCO
HERRING
PIKE PERCH ETC.
SQUID
COD, HADDOCK, HAKE, POLLOCK
SABLEFISH
SHELLFISH
LAKE TROUT
WHITEFISH
SQUETEAGUE
BUTTERFISH
CROAKERS
FLOUNDERS
SCUP (PORGIE)
STURGEON AND SPOONBILL CAT
BLUEFISH
SHAD AND SHAD ROE
SMELT
CATFISH
SUCKERS
1924
1925
TOTAL AMOUNT OF FISH FROZEN PER YEAR 1920 TO 1925.
MILLIONS OF POUNDS
90
80
70
60
50
40
30
20
10
1920
1921
1922
1923
1924
1925

FIG. 1

In general, the more expensive varieties are frozen—salmon, halibut, whitefish, mackerel, etc. Herring, and to some extent squid, are frozen for bait. Ciscoes are frozen almost entirely for smoking purposes. Whiting are frozen to meet the demand in the Central States, while much of the frozen salmon is exported to Europe. The United States are principally exporters rather than importers of frozen fish.

The detailed statistics of fish frozen in the United States are given in Tables 2, 3, 4, and 5. Figure 1 gives a comparison of amounts of various groups of fish frozen in 1924 and 1925. The percentage of the total amount of fish frozen by the several sections of the United States in 1925 is shown by Figure 2.[13]



PERCENTAGE OF THE AMOUNT OF FISH FROZEN BY THE SEVERAL SECTIONS OF THE UNITED STATES IN 1925.

FIG. 2

TABLE 2.—*Fish frozen monthly in 1925, by species, and in 1920–1924, by totals* [a]

Species	Month ended—						
	Jan. 15	Feb. 15	Mar. 15	Apr. 15	May 15	June 15	July 15
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Bluefish (all trade sizes)	94,746	600	14,493	3,810	11,082	12,512	41,705
Butterfish (all trade sizes)	7,320	----------	----------	1,781	8,327	146,666	141,856
Catfish	6,454	1,577	7,734	11,127	98,698	38,594	50,563
Ciscoes (including bluefin, blackfin, chub, lake herring, etc.)	1,026,651	90,562	42,969	149,517	76,309	94,422	63,018
Ciscoes (tullibees)	185,599	91,457	110,312	55,955	36,000	246	2,618
Cod, haddock, hake, pollock	134,607	113,170	175,122	326,679	315,094	122,485	105,106
Croakers	2,100	----------	414	1,500	411,470	69,399	395,532
Flounders	57,168	21,492	37,633	85,394	211,581	206,834	117,072
Halibut (all trade sizes)	453,098	121,227	1,533,414	1,339,498	869,324	1,923,334	1,344,419
Herring, sea (including alewives and bluebacks)	150,625	421,342	224,231	9,096	375,773	244,624	492,886
Lake trout	217,945	50,653	29,884	12,862	63,460	107,333	142,065
Mackerel (except Spanish)	90,220	26,640	48,167	72,251	101,734	1,916,341	648,501
Pike perches and pike or pickerel	321,847	76,174	126,076	65,421	574,547	477,060	59,218
Sablefish (black cod)	72,992	19,359	54,399	8,718	85,920	39,786	387,501
Salmon:							
Silver and fall	154,958	16,651	68,967	45,636	141,587	332,156	446,572
Steelhead trout	----------	23,160	7,600	16,675	2,933	19,670	237,511
All other	42,896	10,314	74,452	1,288,787	87,811	588,269	1,040,399
Scup (porgies)	----------	----------	----------	----------	78,885	338,838	353,375
Shad and shad roe	620	1,724	3,540	21,506	91,494	204,954	17,865
Shellfish	236,627	117,497	101,149	82,051	191,345	143,401	174,639
Smelts, eulachon, etc	83,747	34,296	42,493	39,366	8,918	22,602	505
Squeteagues or "sea trout"	2,601	----------	----------	----------	142,615	131,430	38,001
Squid	----------	287	49,120	540	499,790	1,277,225	375,289
Sturgeon and spoonbill cat	19,865	6,579	14,624	14,553	71,215	62,226	107,540
Suckers	7,635	2,335	26,850	973	464	3,178	223
Whitefish	79,583	103,834	295,701	186,489	88,131	65,338	139,987
Whiting	12,119	410,386	178,199	74,460	299,991	1,410,344	3,657,351
Miscellaneous frozen fish	470,530	432,105	220,280	400,236	913,059	800,653	640,058
Total frozen fish, 1925	3,932,553	2,193,421	3,487,823	4,314,881	5,857,557	10,799,920	11,221,375
Total frozen fish, 1924	3,179,098	2,440,163	2,417,473	2,729,366	6,040,261	8,281,516	11,996,011
Total frozen fish, 1923	2,741,538	1,662,135	1,412,490	1,400,078	5,026,888	7,671,127	11,871,645
Total frozen fish, 1922	2,441,892	1,452,801	1,363,942	1,496,538	1,980,435	5,849,537	7,376,237
Total frozen fish, 1921	4,005,000	2,843,000	1,770,000	2,413,000	2,698,000	9,624,000	10,151,000
Total frozen fish, 1920	2,291,082	2,273,744	2,630,482	2,465,375	3,687,536	10,094,367	12,761,791

[a] These figures have been revised in accordance with further reports received since original publication of data for the month.

[13] Tables taken from Fishery Industries of the United States, 1925, by Oscar E. Sette. Appendix V, Report, U. S. Commissioner of Fisheries for 1926. Bureau of Fisheries Document No. 1010. Figs. 1 and 2 furnished by the U. S. Bureau of Fisheries.

TABLE 2.—*Fish frozen monthly in 1925, by species, and in 1920–1924, by totals*—Continued

Species	Month ended—					Total	Per cent of total
	Aug. 15	Sept. 15	Oct. 15	Nov. 15	Dec. 15		
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	
Bluefish (all trade sizes)	16,638	28,708	267,703	74,196	3,110	569,303	0.62
Butterfish (all trade sizes)	113,372	312,835	640,238	94,069	53,184	1,519,648	1.67
Catfish	3,377	5,861	8,587	31,380	7,627	271,579	.30
Ciscoes (including bluefin, blackfin, chub, lake herring, etc.)	162,156	66,161	44,388	1,091,342	1,845,344	4,752,839	5.21
Ciscoes (tullibees)	8,810	9,634	182,063	74,192	71,548	828,434	.91
Cod, haddock, hake, pollock	179,369	631,744	226,930	330,472	120,641	2,781,419	3.05
Croakers	157,523	122,773	2,442	53,899	4,436	1,221,488	1.34
Flounders	109,843	120,000	30,359	47,527	78,504	1,123,407	1.23
Halibut (all trade sizes)	1,432,984	1,419,346	729,794	395,244	479,473	12,041,155	13.21
Herring, sea (including alewives and bluebacks)	158,145	1,017,650	706,028	959,502	504,367	5,264,269	5.77
Lake trout	138,145	112,811	209,140	790,488	180,995	2,055,781	2.26
Mackerel (except Spanish)	1,989,476	2,472,091	952,611	401,849	228,416	8,948,297	9.82
Pike perches and pike or pickerel	99,413	99,584	230,277	2,187,898	916,140	5,233,655	5.74
Sablefish (black cod)	347,438	274,830	625,904	557,624	144,575	2,619,046	2.87
Salmon:							
Silver and fall	777,276	436,788	949,721	966,997	211,148	4,548,457	4.99
Steelhead trout	610,097	373,104	128,974	33,621	28,033	1,481,378	1.62
All other	1,057,206	812,276	517,354	515,532	88,384	6,123,680	6.72
Scup (porgies)	112,047	2,148	12,612	123	1,500	899,528	.99
Shad and shad roe	4,587	137	133	2,187	2,500	351,247	.39
Shellfish	221,882	278,222	324,423	311,678	273,704	2,456,618	2.69
Smelts, eulachon, etc	4,380	21,288	18,359	47,988	26,738	350,680	.38
Squeteagues or "sea trout"	149,443	465,966	650,306	66,415	650	1,647,427	1.81
Squid	216,097	211,870	220,497	65,909	98,769	3,015,393	3.31
Sturgeon and spoonbill cat	100,761	67,699	85,917	50,722	2,408	604,109	.66
Suckers	2,455	2,847	2,962	8,276	12,801	70,999	.08
Whitefish	45,874	42,772	11,032	642,339	155,918	1,856,998	2.04
Whiting	2,223,927	268,757	253,495	973,701	390,069	10,152,799	11.13
Miscellaneous frozen fish	459,266	1,916,761	560,782	942,540	619,165	8,375,435	9.19
Total frozen fish, 1925	10,901,987	11,594,663	8,593,031	11,717,710	6,550,147	91,165,068	100.00
Total frozen fish, 1924	15,541,641	10,585,272	14,877,934	10,854,873	8,380,536	97,324,144	
Total frozen fish, 1923	13,943,978	16,417,132	12,511,606	6,951,639	9,938,387	91,548,643	
Total frozen fish, 1922	9,121,160	10,826,942	16,830,080	9,344,469	7,069,995	75,154,028	
Total frozen fish, 1921	9,845,000	9,356,000	9,990,000	9,869,000	8,173,000	80,737,000	
Total frozen fish, 1920	13,620,232	11,803,606	11,168,810	9,711,800	9,750,844	92,259,671	

TABLE 3.—*Monthly holdings of frozen fish in the United States in 1925, by species, and in 1917–1924, by totals*

Species	Month ended—					
	Jan. 15	Feb. 15	Mar. 15	Apr. 15	May 15	June 15
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Bluefish (all trade sizes)	287,873	196,732	67,264	32,193	48,655	59,715
Butterfish (all trade sizes)	480,051	365,363	253,329	94,848	43,106	154,945
Catfish	172,927	101,070	44,661	38,352	124,441	131,846
Ciscoes (including bluefin, blackfin, chub, lake herring, etc.)	7,623,852	5,830,439	3,887,880	2,067,075	1,315,934	1,008,139
Ciscoes (tullibees)	853,357	802,336	985,698	1,046,781	969,132	883,460
Cod, haddock, hake, pollock	795,276	605,187	509,747	651,339	796,798	804,987
Croaker	129,765	89,766	19,123	3,754	440,435	478,656
Flounders	336,226	245,819	248,923	274,889	489,348	608,082
Halibut (all trade sizes)	8,507,465	5,740,740	4,108,588	4,402,656	5,179,520	7,206,590
Herring, sea (including alewives and bluebacks)	3,776,670	3,827,486	2,132,352	828,312	785,586	819,447
Lake trout	1,610,461	1,235,694	773,277	410,344	417,885	556,574
Mackerel (except Spanish)	3,241,991	2,483,916	1,553,862	854,320	711,726	2,456,607
Pike perches and pike or pickerel	1,324,993	1,016,647	618,509	324,360	722,773	1,199,810
Sablefish (black cod)	1,038,382	678,031	872,163	592,085	568,261	224,954
Salmon:						
Silver and fall	4,126,643	3,476,931	1,940,826	1,097,303	846,995	1,184,307
Steelhead trout	310,609	267,091	247,745	174,789	96,906	103,492
All other	4,886,949	3,948,546	2,022,251	2,836,151	2,617,159	2,908,282
Scup (porgies)	65,835	24,076	10,047	3,679	80,074	401,133
Shad and shad roe	713,394	739,288	522,909	474,252	611,105	762,217
Shellfish	1,278,772	1,227,341	1,018,057	702,089	656,750	667,756
Smelts, eulachon, etc	522,242	503,278	747,700	862,171	779,707	765,386
Squeteagues or "sea trout"	306,138	164,144	33,315	13,214	152,634	263,473
Squid	1,532,879	1,238,888	840,105	199,876	574,235	1,764,218
Sturgeon and spoonbill cat	497,454	466,696	303,490	244,440	273,737	306,296
Suckers	42,107	40,059	49,993	31,448	29,983	32,458
Whitefish	1,951,795	1,745,562	1,743,448	1,294,723	1,224,435	1,132,629
Whiting	2,780,416	2,296,944	1,334,682	827,252	848,234	2,033,689
Miscellaneous frozen fish	6,113,065	4,676,380	2,974,669	2,059,178	2,343,723	3,060,426
Total, 1925	55,307,587	44,034,450	29,864,613	22,441,873	23,749,277	31,979,574
Total, 1924	52,627,290	40,420,614	29,570,628	21,488,525	21,839,714	27,115,359
Total, 1923	40,032,255	27,069,882	16,723,513	10,589,532	12,312,003	17,779,934
Total, 1922	48,320,212	37,742,262	25,474,714	17,484,975	17,075,917	20,821,345
Total, 1921	53,851,000	42,116,000	33,404,000	28,440,000	26,346,000	32,311,000
Total, 1920	61,510,357	47,904,057	29,958,132	20,632,834	19,803,817	27,779,230
Total, 1919	80,683,761	67,617,478	50,036,475	37,110,856	37,174,104	48,840,359
Total, 1918	51,116,037	35,907,071	28,457,301	26,548,272	31,403,425	50,298,027
Total, 1917	32,234,530	14,727,099	13,374,429	9,516,217	14,040,024	27,791,047

TABLE 3.—*Monthly holdings of frozen fish in the United States in 1925, by species, and in 1917–1924, by totals*—Continued

Species	Month ended—					
	July 15	Aug. 15	Sept. 15	Oct. 15	Nov. 15	Dec. 15
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Bluefish (all trade sizes)	135,699	95,285	103,139	335,288	474,565	547,724
Butterfish (all trade sizes)	275,866	387,932	715,684	1,294,183	1,247,847	1,056,582
Catfish	151,328	111,904	110,507	95,055	105,863	82,448
Ciscoes (including bluefin, blackfin, chub, lake herring, etc.)	746,398	833,540	684,706	539,609	1,541,644	3,180,117
Ciscoes (tullibees)	853,362	824,855	764,274	573,041	510,488	451,232
Cod, haddock, hake, pollock	820,537	926,122	1,582,536	1,564,557	1,523,124	1,104,155
Croaker	1,118,090	1,218,590	1,111,570	866,730	775,331	534,764
Flounders	691,281	745,878	824,185	775,410	710,311	647,035
Halibut (all trade sizes)	8,448,458	9,752,570	10,616,852	10,995,236	9,400,480	7,038,674
Herring, sea (including alewives and bluebacks)	1,109,606	991,553	2,018,314	2,481,383	2,951,672	3,253,802
Lake trout	746,417	819,352	840,348	987,468	1,850,380	2,143,548
Mackerel (except Spanish)	2,880,270	4,596,567	6,867,043	7,643,432	6,910,402	5,342,937
Pike perches and pike or pickerel	1,000,495	825,002	716,983	863,897	2,952,476	3,842,287
Sablefish (black cod)	532,061	851,587	1,082,614	1,601,240	2,145,559	2,153,802
Salmon:						
Silver and fall	1,558,764	2,142,690	2,462,339	3,210,257	3,840,903	3,379,724
Steelhead trout	331,904	654,497	652,261	841,464	730,774	644,580
All other	3,569,736	4,464,728	5,133,344	5,360,481	5,036,230	4,257,296
Scup (porgies)	667,853	736,385	699,321	672,325	544,926	419,557
Shad and shad roe	763,710	749,935	687,870	734,651	702,123	672,014
Shellfish	637,127	733,080	795,964	927,355	1,081,106	1,267,692
Smelts, eulachon, etc	717,405	568,334	583,681	578,451	582,812	650,393
Squeteagues or "sea trout"	366,233	481,108	1,029,771	1,638,534	1,615,814	1,296,381
Squid	2,028,068	2,110,170	2,034,939	2,079,704	1,870,558	1,597,404
Sturgeon and spoonbill cat	365,510	444,625	408,970	403,623	376,572	298,560
Suckers	30,837	32,906	34,282	36,467	43,792	51,104
Whitefish	1,282,559	1,373,567	1,393,188	1,327,803	1,907,364	2,315,779
Whiting	5,208,604	7,065,724	7,022,677	6,700,948	6,773,678	6,144,851
Miscellaneous frozen fish	3,419,991	2,935,029	4,469,186	3,229,172	3,642,565	3,673,838
Total, 1925	40,458,169	47,473,515	55,446,548	58,357,764	61,849,359	58,048,280
Total, 1924	36,036,010	49,026,140	56,606,759	67,024,996	70,405,786	68,324,572
Total, 1923	27,237,105	39,100,868	53,220,398	62,616,212	63,457,565	64,289,945
Total, 1922	25,620,042	32,226,170	41,141,144	54,756,783	54,502,283	48,689,830
Total, 1921	40,160,000	47,431,000	54,469,000	58,899,000	61,228,000	59,125,646
Total, 1920	36,617,706	47,140,132	56,295,975	64,730,531	67,549,377	65,841,000
Total, 1919	59,674,301	65,145,234	69,580,555	76,763,253	78,769,101	74,202,339
Total, 1918	64,864,532	82,554,798	89,203,946	93,811,909	99,631,789	96,600,247
Total, 1917	38,431,221	44,024,666	47,197,660	60,676,722	70,938,957	69,986,671

TABLE 4.—*Fish frozen in 1925, by geographical sections and by months*[1]

Month ending the 15th of—	New England	Middle Atlantic	South Atlantic	North Central, East	North Central, West	South Central and Mountain	Pacific	Total	Per cent
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	
January	203,523	1,180,883	20,778	1,685,205	407,656	102,816	331,692	3,932,553	4.31
February	305,352	284,905	15,780	344,941	637,455	125,603	479,385	2,193,421	2.41
March	153,001	281,922	14,350	911,939	354,174	90,735	1,681,702	3,487,823	3.83
April	460,556	339,903	13,850	605,821	281,937	108,190	2,504,624	4,314,881	4.73
May	1,307,604	1,842,571	147,466	860,186	328,475	151,127	1,220,128	5,857,557	6.43
June	3,659,546	3,191,453	71,630	557,356	150,897	115,403	3,053,635	10,799,920	11.85
July	4,870,932	1,590,684	190,208	385,089	374,993	108,040	3,701,429	11,221,375	12.31
August	4,662,590	1,075,488	163,121	366,714	260,868	66,909	4,306,297	10,901,987	11.96
September	4,203,276	1,717,800	275,070	298,216	324,521	45,545	4,730,235	11,594,663	12.72
October	2,121,635	2,392,983	109,936	474,231	410,097	26,496	3,057,653	8,593,031	9.43
November	1,838,686	3,945,272	76,578	2,613,414	769,258	25,814	2,448,688	11,717,710	12.85
December	774,297	1,072,256	38,411	2,771,552	949,431	84,106	860,094	6,550,147	7.17
Total	24,560,998	18,916,120	1,137,178	11,874,664	5,249,762	1,050,784	28,375,562	91,165,068	
Per cent of total	26.94	20.75	1.25	13.03	5.76	1.15	31.12		100.00

[1] New England includes the 6 States of that section; Middle Atlantic—New York, New Jersey, and Pennsylvania; South Atlantic—Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, and Florida; North Central, East—Ohio, Indiana, Illinois, Michigan, and Wisconsin; North Central, West—Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, and Kansas; South Central and Mountain—Kentucky, Tennessee, Alabama, Mississippi, Louisiana, Texas, Oklahoma, Arkansas, Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, and Nevada; Pacific—Washington, Oregon, California, and Alaska.

TABLE 5.—*Fish frozen in 1925, by geographical sections and by species*

Species	New England	Middle Atlantic	South Atlantic	North Central East	North Central West	South Central and Mountain	Pacific	Total
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Bluefish (all trade sizes)	4,439	441,766	----------	115,568	----------	7,530	----------	569,303
Butterfish (all trade sizes)	153,775	1,311,983	29,097	24,633	160	----------	----------	1,519,648
Catfish	19,135	8,688	----------	53,761	175,742	14,253	----------	271,579
Ciscoes (including bluefin, blackfin, chub, lake herring, etc.)	11,696	977,531	----------	3,108,701	636,286	18,625	----------	4,752,839
Ciscoes (tullibees)	25,445	219,431	14,220	401,751	105,673	2,312	59,602	828,434
Cod, haddock, hake, pollock	1,613,233	483,298	13,730	85,356	106,814	----------	478,988	2,781,419
Croakers	414	804,806	346,123	70,145	----------	----------	----------	1,221,488
Flounders	427,906	585,383	----------	10,387	22	----------	99,709	1,123,407
Halibut (all trade sizes)	419,904	323,368	4,828	1,329,191	184,467	2,400	9,776,997	12,041,155
Herring, sea (including alewives and blueblacks)	4,002,057	398,667	55,000	178,288	249,987	2,151	378,119	5,264,269
Lake trout	3,995	377,536	----------	1,351,820	287,653	4,085	30,692	2,055,781
Mackerel (except Spanish)	6,526,800	1,547,301	12,250	140,841	59,397	----------	661,708	8,948,297
Pike perches and pike or pickerel	2,795	3,124,869	----------	1,935,443	165,848	75	4,625	5,233,655
Sablefish (black cod)	----------	900	----------	25,096	41,719	----------	2,551,331	2,619,046
Salmon:								
Silver and fall	183,314	153,871	100	222,083	106,054	----------	3,883,035	4,548,457
Steelhead trout	----------	18,581	----------	817	----------	----------	1,461,980	1,481,378
All other	341,183	137,454	----------	238,847	49,272	30,066	5,326,858	6,123,680
Scup (porgies)	238,292	658,792	----------	----------	1,500	----------	944	899,528
Shad and shad roe	59,765	95,775	----------	22,127	4,402	1,240	167,938	351,247
Shellfish	557,273	637,957	160,453	354,542	131,517	7,889	606,987	2,456,618
Smelts, eulachon, etc.	69,672	26,247	----------	128,441	3,605	----------	122,715	350,680
Squeteagues or "sea trout"	140	1,518,600	128,037	----------	----------	650	----------	1,647,427
Squid	2,524,318	438,393	----------	43,210	9,185	----------	287	3,015,393
Sturgeon and spoonbill cat	----------	359,641	3,100	24,470	----------	64,133	152,765	604,109
Suckers	----------	2,378	----------	66,167	2,454	----------	----------	70,999
Whitefish	830	613,374	----------	1,019,027	217,513	3,894	2,360	1,856,998
Whiting	6,452,962	1,952,967	----------	18,319	1,728,551	----------	----------	10,152,799
Miscellaneous frozen fish	921,655	1,696,563	370,240	905,633	981,941	891,481	2,607,922	8,375,435
Total	24,560,998	18,916,120	1,137,178	11,874,664	5,249,762	1,050,784	28,375,562	91,165,068

SCIENTIFIC PRINCIPLES INVOLVED IN REFRIGERATION

Heat and its relation to other forms of energy is one of the most intricate and difficult branches of science, and the practical refrigeration man need not be a master of it. Yet there are certain principles, the understanding of which is of great value to an intelligent conduct of a refrigerating business. Reference will be made, in connection with the many details of this subject, to the more important scientific papers which the reader who is interested to pursue the subject more extensively may consult.

NATURE OF HEAT

All matter or substance consists of extremely minute particles or molecules. Motion of these molecules is heat. Many of the simpler substances, for example water, are capable of existing in three states—solid, liquid, and gas—the differences being only in the amount of motion in the molecules and their distance apart. In the gaseous state (steam) the molecules are far apart and in great activity or motion, like a swarm of insects, each free to move long

distances with little interference. Unless confined they will keep on going or expanding and diffusing into space. If the motion is reduced (that is, if the gas is cooled), the molecules travel less freely and for shorter distances, the gas volume contracts, and a liquid (water, in the example chosen) is formed. In this condition the molecules move less freely, but still get about with many collisions and glancing motions. The whole mass is fluid and will assume the shape of its container, while at the exposed surface many of the molecules escape into space—a process known as evaporation. If more heat is taken from the water (that is, if the motion of the molecules is still further reduced), the molecules are no longer free to move about from place to place, but each is confined to occupy a small space, within which it performs a restricted vibratory motion. In this condition, where the molecules are too much crowded to move freely, the substance is a solid (ice). In solids the molecules often are found to be arranged in definite rows or patterns, in which case the solid is a crystal of definite geometric form. Only at absolute zero (459.2° F. below zero) are the molecules absolutely at rest, but this temperature has never been attained.

The differences between solid, liquid, and gas are thus purely differences in the amount of motion in the molecules—hot, gas; cool, liquid; cold, solid. The solid condition is the frozen condition, ordinary iron, for example, being frozen iron. Cold is a purely relative term meaning less heat. Ordinarily we think of things as cold when they contain less heat than we are accustomed to in our sourroundings.

TEMPERATURE AND HEAT UNITS

The degree of motion of molecules is expressed in temperature and is measured by the thermometer. Temperature alone tells us nothing about the quantity of heat. This is obvious if we consider that a drop of molten iron may have a temperature of 2,720° F., yet when dropped in a bucket of cold water the water is not noticeably warmed. This is because the *quantity* of heat in the drop of iron is too small, though the temperature of the drop is very high. The quantity of heat in the English system is measured in British thermal units (B. t. u.); a British thermal unit is defined as the amount of heat required to raise the temperature of a pound of water 1° F. If a pound of water is to be warmed from 32° to 100° F., 68 B. t. u. of heat would be required; 2 pounds of water would require 136 B. t. u. to be warmed 68°. Likewise, if 1 pound of water is to be cooled from 100° to 32° it must give off 68 B. t. u.

FREEZING

If water has been cooled to 32°, its freezing point, it can not ordinarily be cooled any further until all of it is frozen, after which the temperature of the frozen water begins to drop again if heat continues to be extracted. The heat that exists in water and all other crystallizable liquids, and which must be extracted to convert it to a solid without change of temperature, is called *latent* heat. The term is often misapplied to the animal heat in fresh fish. The latent heat

of water is 144 B. t. u.; that is, 144 B. t. u. of heat must be taken out of a pound of water to convert it from a liquid at 32° to a solid at 32°. After it is all frozen the ice may be cooled further, but ice requires only about one half B. t. u. per pound to cool it 1°.

An example of this may help to clear the matter further. How much refrigeration is required to cool 10 pounds of water from 100°, freeze it, and chill the ice to 0°? To cool the water from 100 to 32° would require the removal of 68 B. t. u. per pound, or 680 B. t. u. To freeze the water at 32° would require the removal of 144 B. t. u. per pound, or 1,440 B. t. u. To reduce the ice to 0° would require the removal of one-half B. t. u. per pound per degree, or $\frac{1}{2}\times10\times32=160$ B. t. u. The sum of the number of B. t. u. required to be removed to cool the water from 100 to 32°, to freeze it, and cool the ice to 0° is thus 680+1,440+160 B. t. u., or 2,280 B. t. u.

A ton of refrigeration is, according to accepted usage, the amount of refrigeration required to freeze 2,000 pounds of water at 32° to ice at 32°, or $2,000\times144=288,000$ B. t. u. A ton of ice in melting absorbs 288,000 B. t. u. It will cool off 288,000 pounds of water 1°, or 28,800 pounds 10°, etc.

Fish consist of 60 to 82 per cent water. Neglecting the nonwater portion of, say, haddock, which contains about 80 per cent water, to freeze a ton of haddock would require approximately $0.80\times288,000=230,400$ B. t. u. of refrigeration. It is customary to consider fish as all water for purposes of calculation, the difference being a safe allowance for conservative estimates.

WHAT HAPPENS WHEN FISH FREEZE

What was said above about freezing substances to a solid at a definite point without change of temperature until all the substance is solid applies to pure simple substances like water. But a fish is not all water; it is made up of millions of microscopic cells. These cells may be conveniently thought of as something like hen's eggs with the limy shell removed but with the membrane lining the shell left on. It would be a membranous bag inclosing a semigelatinous or albuminous substance like the white of raw egg. In fact, an egg is a large cell; reduced by millions in size and multiplied by millions in number it represents fairly well what the flesh of fish is made of. The gelatinous contents of these cells is about 80 per cent or more water. If the fish freezes extremely rapidly, the jelly solidifies as a mass of frozen jelly; but if slowly, the water has a tendency to separate from the jelly as microscopic ice crystals. The water diffuses out of the jelly to build these crystals larger and larger as freezing proceeds, until finally a large part of the water has separated out as ice. These crystals—long, sharp needles—may rupture the delicate cell membranes, so that when the fish is defrosted the juice is free to run out. Hence, the desirability, as will be referred to often later, of the most rapid freezing.

While pure water freezes at 32°, if anything is dissolved in the water its freezing point is lowered. The water in fish contains mineral and other substances in solution. The fish, therefore, does

not begin to freeze until it is cooled to 31.5° or 30.5°; but it will not freeze hard and solid even at this temperature, because as part of the water freezes out what is left has a higher concentration than it had at the beginning, and a lower temperature is required for further freezing. Probably not all the water in fish is ever frozen at ordinary freezing temperatures. A fish will be apparently hard at 20°, but at 0° it is harder. At 5° F. about 17 per cent of the water remains unfrozen; at 31° F. below zero, about 2.66 per cent remains liquid. Only at about 75° below zero is it all frozen.

CONDUCTIVITY

Heat is conducted through any substance, as, for example, when one end of a metal rod is heated the other end becomes warm. This conduction is a matter of the molecules striking against one another and transmitting the motion. Some substances conduct heat better than others. All metals are relatively good conductors, silver and copper being the best. Air and all gases generally are exceedingly poor conductors, especially if they are prevented from circulating. This is true because the molecules are farther apart and collide less frequently. For the same reason, solids generally are better conductors than liquids.

Substances like cork, feathers, wool, sawdust, etc., that hold much air entrapped, are poor conductors of heat and are called insulators. When heat or cold must be confined in a space it must be surrounded by an insulator. Cork, wool, and like materials serve this purpose when they are dry because of the air they contain, but when water enters them and drives out the air the insulating value is impaired, because, as already said, liquid is a better conductor of heat than gas.

The rate of transfer of heat through an insulating medium is approximately inversely proportional to the thickness of the insulating substance. About half as much heat will flow per minute through a square foot of cork 2 inches thick as through a square foot of cork 1 inch thick, and a third as much will flow through a slab 3 inches thick. On the other hand, when it is desirable to cause heat to flow as rapidly as possible from one body to another the path of travel of the heat must be through as good a conductor as possible. For example, in a sharp freezer, where fish are in a metal pan and the pan rests on a metal pipe, the heat travels freely through the points of contact between fish and pan and pan and pipes; but most of the fish is in contact with air, which is an exceedingly poor conductor, hence the comparatively slow freezing attained in this way. If more rapid freezing is to be attained the fish must be brought into intimate contact with a good conductor that is refrigerated.

The rate of transfer of heat from one place to another is in direct proportion to the difference in the temperature of the two places. For example, a can of water at 32° is immersed in brine at 22°. The difference in the temperatures of the water and the brine is 10°. Another can of water at 32° is immersed in brine at 12°. The difference in temperature in this case is 20°. The water in the second can will freeze twice as rapidly as the first if the conditions remain constant, because the difference in the temperature of water and brine is twice as great in the second case as in the first. Another can in brine at 2° would freeze three times as fast as the one at 22°. This simple fact,

taken together with the desirability of rapid freezing of fish, explains why such cold temperatures are necessary in sharp freezers.

Ice is about four times as good a conductor of heat as water. When a fish is freezing the outer frozen part (containing about 80 per cent ice) conducts heat outward about four times as fast as it did before it was frozen; but when a frozen fish is thawing the outer thawed layer conducts heat only about one-fourth as rapidly as it did while it was frozen. A fish will therefore freeze more rapidly than it will thaw if there is the same difference between the temperature of the air and the fish in both cases.

CHANGES THAT TAKE PLACE IN FISH AND THEIR PREVENTION BY COLD

Two classes of changes that take place in fish will be considered in this section, (*a*) those that occur in fresh fish and (*b*) those that occur in frozen fish.

CHANGES IN FRESH FISH[14]

When a live fish is taken from the water its parts are all intact stomach usually full of food, intestines with digested food and residue, and its body and gills covered with a heavy mucus. Its muscle tissue is able to contract, and the entire fish is chemically normal and wholesome and all internal tissues sterile or nearly so. When the fish dies there begins a series of many kinds of changes that affect the wholesomeness and appearance of the fish. To prevent these changes from taking place is to preserve the fish. In order to do this intelligently an understanding of the nature of these changes is valuable.

COLOR OF THE SKIN

The first noticeable change in the fish after death is in the coloring of the skin. This color is due largely to variously colored pigment cells, which are contractile and controlled by nerves. Upon release of nervous control at death these pigment cells contract, the blend of colors becomes dull, and the appearance is generally less attractive than that of the living fish.

RIGOR MORTIS

One of the earlier changes in the fish after it dies is a development of lactic acid in the muscles, causing them to contract, the fish in consequence becoming rigid. This condition is called *rigor mortis*. The warmer the fish the sooner rigor mortis begins and the shorter time it lasts. The colder the fish (not frozen) the slower rigor is to appear and the longer it lasts. Rigor is a sign of freshness and

[14] See A. G. Anderson, "On the decomposition of fish." Fishery Board for Scotland, 26th Annual Report, 1907, Part III, pp. 13–39. Edinburgh. Clough, R. W., "A biochemical study of Pacific coast salmon, with particular reference to the formation of indol and skatol during decomposition." University of Washington, Department of Chemistry. 27 pp., bibliography. The University Press, Seattle. L. Gross, "An investigation into the rate of putrefaction in the common food fish caught in and around Passamaquoddy Bay, New Brunswick." Department of the Naval Service, Biological Board for Canada, Contributions to Canadian Biology, 1918–1920, Vol. IX, pp. 99–102. Ottawa. Hunter, A. C., "Bacterial growths in decomposing salmon." Journal of Bacteriology, Vol. V, 1920, pp. 543–552. Also, "The sources and characteristics of bacteria in decomposing salmon." *Ibid.*, Vol. VII, 1922, pp. 85–109.

wholesomeness, well recognized by fishmongers. There is some question as to whether fish are best frozen before, during, or after rigor.[15] Some investigators have observed that cod frozen before rigor had a dry and disagreeable taste. Others have thrown doubt on this conclusion and indicated by experiments that it is possible to have fish of good flavor in both cases.

AUTOLYSIS

As rigor subsides another change comes about, perhaps assisted by the lactic acid that causes rigor. This is autolysis, or self-digestion of the tissues. It is an important change that requires some explanation.

There are certain substances called enzymes that are capable of decomposing or breaking down complex into simpler substances. A familiar example of such a substance is pepsin in the stomach, which breaks down the complex substance (protein) of lean meat into simpler substances that dissolve in water to form liquid solutions. This liquefaction of food is digestion and serves to prepare the food for absorption into the blood through the intestinal wall. There are many such enzymes in the animal body, most of the tissues containing enzymes capable of liquefying or digesting them. These enzymes serve an important purpose in the living animal, but upon its death they set to work to soften and liquefy the tissues. This self-digestion of fish substance is called *autolysis*.

The products of autolysis are not unwholesome. Indeed, a certain amount of autolysis or ripening, as butchers call it, is desirable in red meats, for it makes them tender and juicy, and most people prefer the flavor. In fish, however, autolysis, while harmless, gives rise to a fishy flavor that is distinctly objectionable. Fish that have undergone autolysis are soft and flabby. Impressions made on the fish with one's fingers remain when the fingers have been removed. Autolysis occurs in fish after rigor has passed away. It is hastened by warmth and retarded by cold. The maximum rate is at temperatures varying with different fishes from about 65 to 81° F. Bruises promote autolysis, for it has been shown that bruised or crushed meat softens and digests itself much more rapidly than meat not bruised. Autolysis is prevented entirely by freezing the fish solid, but it begins again when the fish is defrosted. Salt in small quantities increases autolysis. Slowly frozen fish autolyze more rapidly than fresh fish, while rapidly frozen fish autolyze less rapidly.[16]

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[15] The subject is discussed by the following authors, whose works are extensive theoretical studies of scientific principles of freezing fish: W. D. Richardson and E. Scherubel, "The deterioration and commercial preservation of flesh foods." Journal of the American Chemical Society, Vol. XXX, pp. 1515–1564. Easton, 1908. J. M. Bottemanne [Ed.], "Verslag van de door Nederlandsche Vereeniging voor de koeltechniek ingestelde Commissie voor de Vischconserveering, etc." Delft, 1915. See also, Third International Congress of Refrigeration, Chicago, 1913. R. Plank, E. Ehrenbaum, and K. Reuter, "Die Konservierung von Fischen durch das Gefrierverfahren." 248 pp. Zentral Einkaufsgesellschaft, Berlin, 1916. See also, Stiles, footnote 45, p. 580, and Ogura and Fujikawa, footnote 20, p. 526.

[16] See Oya, Takeo, and Kiyoshi Shimada on the "Autolysis of fish muscle." I. Journal of the Imperial Fisheries Institute, Vol. XIX, No. 3, 1923. Oya, Takeo, Ei-etsu Sumi, and Kiyoshi Shimada II. *Ibid.*, Vol. XXI, 1926, pp. 49–149. Callow, E. H., "The autolysis of the muscle of the cod." Biochemical Journal, Vol. XIX, 1925, pp. 1–6. Cambridge.

PUTREFACTION

Putrefaction is caused by bacteria or microscopic living things entirely too small to be seen without a microscope. They exist almost everywhere. Sea water and other natural waters contain millions of them. As long as fish are alive and healthy bacteria do them no harm, though they occur in the body slime, on the gills, and in the intestines and probably, also, to some extent in the blood and flesh. When the fish dies there is no longer any resistance to the growth of bacteria; they begin at once to multiply rapidly in the body slime and in the intestines, soon invading the flesh and gills, break down and disintegrate the intestinal walls, and ultimately spoil the fish.

Bacteria do not obtain their nourishment by biting or digging in. They are plants by nature and live, as other plants do, by absorbing food from their surroundings. They secrete enzymes from their bodies; these enzymes liquefy or digest the surrounding flesh, and this digested flesh is then absorbed by the bacteria. The products of bacterial action, unlike those from autolysis, are usually offensive and unwholesome. The process of decomposition brought about by bacteria is known as putrefaction.

To prevent putrefaction, the bacteria must be killed or their activities prevented. Bacteria are killed by cooking and also by certain chemicals, both of which agencies are impracticable for fresh fish. Their activities can be retarded by low temperature, which greatly slows down the multiplication of bacteria. Ice temperature serves well to delay putrefaction for several days.

Bacteriological investigation [17] has shown that development of bacteria in fish is arrested by freezing, and that the bacterial content of fish after a term of storage was essentially the same as it was when the fish went into storage.

As the source of infection of fish is usually the surface slime, gills, and intestine, it follows that fish should be washed before freezing, unless they are perfectly fresh at the time, and that preferably they should be gutted and the gills removed. Gutting is, however, not always desirable because of trade requirements.[18]

CHANGES DURING THE FREEZING PROCESS

Some reference already has been made to the freezing of water in the tissues of fish. When fish are exposed to a low temperature they freeze—that is, they become solid—apparently simple enough, but in reality a very complex phenomenon. Exactly what happens depends largely on just how the freezing is done.

GROSS EFFECTS OF SLOW AND RAPID FREEZING

The most important single factor that affects the internal condition of the fish is the speed of freezing. If a fish is placed in a sharp freezer or cold room the temperature of the entire fish is gradu-

[17] See, for example, H. D. Pease, "Effect of prolonged periods of cold storage on the bacteria in the tissues of fish." Proceedings, Third International Congress of Refrigeration, Chicago, 1913, Vol. I, Sec. III, pp. 560–573.

[18] See footnote 25 on p. 537.

ally lowered. When the body of the fish reaches the freezing point of body juice, it begins to freeze. In general, the outer parts of the fish are colder than the inner parts, though there is no sharp line of demarcation. The fish gradually becomes firm, and finally hard throughout. In this case the factor controlling the speed of freezing is the removal of heat from the surface, for the heat flows from the interior of the fish to the surface as fast as it can be carried away by the air, which is a very poor conductor of heat. When heat is removed very rapidly, as by immersing it in very cold, rapidly moving brine, the factor that limits the rate of freezing is the conductivity of the fish itself. The surrounding brine, being a good conductor and in rapid motion, removes the heat from the surface as fast as it can be conducted from the inner parts. The outer parts of a fish may be frozen hard, while the innermost parts are still quite unfrozen. The outer frozen shell becomes thicker and thicker as freezing proceeds inwardly, always simply inserted from the inner unfrozen core until freezing is complete. The slowly frozen fish is highly acceptable, while rapidly frozen fish are of a very poor consistency. Salmon like meat have yet other profound differences in microscopic structure that will be referred to later.

CHANGES IN VOLUME

When water is freezing expands by about 9.5 per cent of its volume. Fish expand accordingly, in proportion to the amount of water present and the amount of that present which is frozen. It is not all frozen in ordinary practice. It has been shown by measurements of expansion that if cells are all the water is frozen until extremely low temperatures are reached (about 100° F. below zero). It is supposed that some of the water remains unfrozen in the "capillary" condition. In fish muscle from 10 to 11 per cent water (by expansion) has to be allowed at from 12 to 13 per cent of volume. Whether this expansion is responsible for any of the structural changes in fish, such as rupture of cell walls or destruction of cell membranes, is an open question. It is not now considered to be so important as it was some years ago. Expansion is of importance where fish are frozen confined in molds or cans where allowance must be made for expansion. It can not be prevented or resisted.

SOLIDIFICATION OF PROTEIN GELS

As stated previously, the cell contents of fish are a semiliquid gel of proteins in water, with small amounts of inorganic substances in solution. It has been reported by various investigators that such gels on being frozen and under certain conditions become coagulated. In the report of the Food Investigation Board of Great Britain for 1920 it is shown that egg albumen, if frozen as a concentrated salt solution (but 25° F., will deposit as a liquid similar to what it was in its unfrozen state, but that if frozen at a moderately low temperature it can not be restored to its original condition by dissolving but will be coagulated. Likewise, if frozen with extreme rapidity in liquid air and defrosted with great rapidity in warm water it is not coagulated. These experiments indicate that there

is a temperature zone below 21° in which coagulation occurs, but that if the albumen is passed quickly through this zone in freezing and defrosting coagulation does not occur. Coagulation that is progressive through the storage period has been observed in frozen haddock.

Brine-frozen fish, not being damaged by internal crystallization, are, because of coagulation, firmer than fresh fish. They are of a firmness strongly suggesting rigor mortis, even after months of storage, and this firmness does not pass away after a brief period as rigor mortis does. Kept in a cool place, brine-frozen fish will remain in this artificial rigor for days, until they are spoiled. The effect probably is due to a small amount of salt that penetrates during the freezing.

HÆMOLYSIS

The red substance of blood—hemoglobin—is contained in microscopic corpuscles. On freezing, many of these corpuscles are ruptured, and the contained red hemoglobin diffuses into the blood plasma and surrounding tissues, discoloring them. This is noticeable in fish mainly in the neighborhood of the large arteries, especially those near the backbone, where the red matter diffuses into and discolors the muscle tissue.

INTERNAL CRYSTALLIZATION

The freezing of fish is essentially the freezing of a watery gel. A large part of the water is transformed into the crystalline solid state. It is well known to chemists that when substances crystallize the size of the crystals formed is determined by the time required for them to form. Diamonds are large crystals of carbon, requiring prolonged periods to form. Man, in the short time available for his processes, has been unable to duplicate nature's effort. Rock candy is sugar crystallized slowly over a period of days or weeks. Fudge is also sugar, but is crystallized quickly by cooling a hot solution in a few seconds. One is composed of large crystals, the other small. Water frozen slowly to ice in ice factories splits easily because its internal structure is characterized by large crystal faces or planes of cleavage, while rapidly frozen ice is hard and shatters like stone because its internal crystals are small and numerous. Crystals grow. A nucleus or seed is formed and more substance is laid on in layers, if time permits, until the liquid substance is exhausted in building large crystals. If heat is extracted too fast, this growth does not have time to take place, and the crystals are small and numerous.

This principle applies to the freezing of fish. When a piece of fish is frozen with extreme rapidity by dipping in liquid air and examined under the miscroscope while still frozen, no perceptible change except solidification will be found to have taken place; but if it is frozen somewhat less rapidly (as in the outer portion of fish frozen in very cold brine) and examined while still frozen, there will be observed several parallel columns of clear ice running lengthwise of the muscle fibers. Part of the water originally contained in the protein gel has separated and frozen as long crystals of clear ice. If this piece of fish is defrosted, the water is slowly reabsorbed

FIG. 3.—Cross section of halibut frozen slowly in ordinary sharp freezer and defrosted. Note honeycombing of tissues by ice crystals. Courtesy, Atlantic Coast Fisheries Co.

FIG. 4.—Cross section of halibut frozen rapidly (in brine). The tissues are intact. The white dots are reflection of light from surface moisture. Courtesy Atlantic Coast Fisheries Co.

into the protein. Virtually, if not absolutely, the changes that occur in freezing of this degree of rapidity are reversible on thawing. In a yet slower rate of freezing, such as occurs in the inner portions of brine-frozen fish, one single large column of ice forms in the muscle fiber; but here, also, little practical damage is done.

In very slow freezing large ice crystals are formed—so large that they do not remain in the muscle fibers or cell. Cell walls are ruptured and the crystals form in the interstitial spaces. When such fish are defrosted, the juice runs out of the fish, carrying much of the valuable fish substance with it. Unfortunately, this is the kind of freezing that commonly occurs in "sharp" freezers and accounts for the many efforts that have been made in recent years to achieve more rapid freezing. Especially in large fish, such as halibut, large crystals, half an inch or more long, may be extracted easily from the tissues; and the tissues when defrosted are characterized by a honeycomb structure. Compared with fresh fish, the flesh is dry and the taste flat.

Furthermore, it was shown that autolysis is promoted by bruising. The formation of large internal crystals is equivalent to a severe bruising or physical damage to all the tissues of the fish. Such fish on defrosting autolyze very rapidly.

CHANGES DURING COLD STORAGE

If frozen fish are held for a protracted time in cold storage, other changes may occur.

BLOOD PIGMENTS

The red coloring matter of blood—hemoglobin—is sensitive to the gases of the air. On long standing in the presence of air, hemoglobin is converted to methemoglobin, a brownish-gray substance that gives the color to corned beef. The blood of fish after prolonged storage undergoes this change. The writer has prevented it experimentally by the use of substances like carbon monoxide and nitric oxide, which form stable red compounds with hemoglobin.

DESICCATION

It is universally known that water will evaporate when exposed to dry air. That ice also will evaporate is not so well recognized, yet it is so. An understanding of the laws of vapors is necessary to a clear conception of the movements of moisture in a cold-storage room.

If a pan of water is placed in a closed chamber, and if the air in the chamber is not already saturated with water vapor, water will evaporate until the vapor (or air) in the chamber is saturated—that is, until it contains all the water that it will hold. How much water will it hold? This depends on the temperature of the chamber. The warmer the chamber the more water is required to saturate it. If the temperature in a saturated chamber is raised, more water will evaporate; if it is lowered, some will condense as dew if the temperature of the condensing surface is above 32° F., or as ice or snow crystals if below this point.

If moisture is present in a sealed room, and if the temperature of the room is constant and uniform throughout, the vapor will soon come to saturation and remain saturated as long as the conditions are not changed.

Table 6 shows the number of grains of water vapor per cubic foot of saturated vapor at cold-storage temperatures.

TABLE 6.—*Weight of a cubic foot of saturated moisture*

Temperature, °F.	Moisture per cubic foot, grains	Temperature, °F.	Moisture per cubic foot, grains
−20	0.167	+20	1.244
−10	.286	+30	1.942
0	.479	+40	2.863
+10	.780		

These conditions of constancy and uniformity of temperature are not realized in a fish cold-storage room. The temperature fluctuates from hour to hour or day to day. If a room is at 0°, each cubic foot of saturated air contains 0.479 grain of water vapor. If the temperature rises next day to 10°, 0.780 grain, or nearly twice as much water, is required to saturate the air, and this must evaporate from the fish. (The quantities are actually somewhat smaller because the juice of fish is not pure water.) The temperature in the room also is not uniform. Heat is coming into the room through the walls, etc., and is being absorbed by the cold pipes. The fish, being near the walls, on the floors, and surrounded by air that is warmed from the same sources, are warmer than the pipes, which are absorbing the heat. The saturation point is lower at the pipes and higher at the fish. Under these conditions the moisture will evaporate steadily from the fish but can not saturate the air because the cold pipes condense the moisture. There is thus a continuous travel of moisture from fish to pipes, which will dry the fish completely unless remedial measures are taken.

The commonest remedial measure is an ice glaze on the fish. The glaze, being of pure water, has a slightly greater tendency to evaporate than the juice of the fish, and, being exposed, evaporates first. Other practical measures will be considered in more detail later.

RUSTING

The fats in fish are a mixture of fatty substances, some of which are unsaturated. That is to say, they are capable of combining with either oxygen or hydrogen under proper conditions. They combine directly with oxygen on exposure to air, or they may become "hydroxylated" by combining with both oxygen and hydrogen, in which case they are rancid. When they take oxygen from the air they become viscous or rubbery, as linseed oil becomes on drying when applied as paint.

The tissues of fish contain enzymes that are capable of decomposing fats, and as long as the fats are in the presence of their mother tissues (as they are in stored fish) they are subject to decomposition.

When decomposed, they are readily attacked by oxygen and form various unpleasant substances; that is, they become rancid. This decomposition and oxidation occurs in the cold-storage room unless measures are taken to prevent it and is manifested by a yellowish, rusty, gummy accumulation on the surface of the fish, especially around the bases of the fins and, in the case of gutted fish, in the belly cavity. Cut surfaces are prone to rust.

These changes are chemical and, in common with chemical changes generally, are accelerated by heat and retarded by cold. For example, ethyl acetate, a fatty substance, at 72° decomposes one-half as fast as it does at 104°; at 32° it decomposes about one-seventh as fast, and at 18° only one-twentieth as fast as it does at 104°. The rate of decomposition would be even lower at the temperatures commonly found in fish cold storages, namely, 10 to 0°. It follows that low temperatures will prevent rusting, or at least greatly reduce it. In practice it has been found that 8° F. is about the highest temperature at which fat fish can be kept for ordinary storage periods without serious rusting. Lower temperatures are recommended, and many fish freezers regularly maintain temperatures of 5 or even 0°.

The oxidation of fat generates heat. The rising temperature in turn accelerates oxidation. This vicious cycle may ruin fish like smelt, which are particularly liable to rust. The writer has seen smelt completely ruined and covered with mold, though they had been kept at 5° F. The mold could not have grown at that temperature. Rapid oxidation had raised the temperature to a point where the mold could grow. The fat had run out of the boxes copiously. This is, of course, an extreme condition—small fish, exposing much surface without glaze, and very rich in highly oxidizable fat. Glazing is a great help in preventing oxidation of fat but is not completely efficacious without a low temperature.

LOSS OF SAVORY SUBSTANCES

Fish that have been frozen and stored for a long time frequently are observed to have lost much of their flavor. We do not know definitely just what substances in fish are responsible for flavor. Most probably the flavor is the blend of flavors and odors from many substances that are present in small quantities. The loss of flavor or odor possibly may be caused by (1) escape of volatile substances by evaporation, (2) reaction of the atmospheric gases (oxygen and carbon dioxide) with the constituents of the fish, or (3) reactions between or among the various constituents of the fish themselves. The last-mentioned of these would seem more likely to increase than decrease the flavor. If loss is caused by evaporation of savory substances or by reaction with atmospheric gases, the remedy lies clearly in a protecting glaze that seals in the natural constituents of the fish and excludes the air. In practice it is common experience that fish held at low temperature and fully protected by a glaze lose nothing of taste or flavor in months or even years. It seems much more likely that the loss of flavor often observed occurs at the time of defrosting fish that have been frozen slowly. The loss of juice made possible by internal crystallization easily accounts for the loss of soluble principles that give taste and flavor as well as nutriment.

INTERNAL CHANGES IN FISH IN STORAGE

Reuter, in the German work already referred to, observed changes in the consistency of fish flesh that are progressive in prolonged storage. These changes occur in fish frozen by any method. Immediately after rapid freezing and defrosting the tissues of haddock, for example, resemble those of fresh fish so closely that one can scarcely distinguish the difference, but in storage they begin to show changes after a time. Reuter's observations are shown by the following scheme:

Term of storage	Consistency of tissues after defrosting	Tendency of juice to exude from fish spontaneously after defrosting
24 hours	Firm as fresh muscle. Gelatinous consistency when rubbed or squeezed between fingers.	Cut surfaces dry; free outflow of juice at a minimum; on pressure almost none could be squeezed out.
18 days	Muscle still tenacious, viscous, and gelatinous, though slightly less than in above.	Cut surfaces dry; small drops of tissue juice flows out spontaneously; on pressure the tissue juice runs out in moderate abundance.
103 days	Muscle much less gelatinous and viscous; also dryer than preceding.	Juice runs out spontaneously a little more freely than in the preceding; on pressure it runs out very freely, leaving the muscle fibers dry.
149 days	No gelatinous property; fibers crumbly and dry.	Cut surface moist; spontaneous outflow of tissue juice not more considerable than after 18 or 103 days' storage, but on pressure the juice continuously exudes as if out of a sponge, so that the muscle fibers remain a friable and plastic mass.

In 1922 [19] the present writer suggested, on theoretical grounds, that it was possible that fish containing only minute ice crystals immediately after freezing might contain larger ones after a period of storage. There was reason to believe that, because of fluctuations in temperature in storage, the larger crystals might grow at the expense of the smaller ones. The Japanese investigators Ogura and Fujikawa [20] report in a recent publication that this is true, though they do not give, in the English summary (the publication itself is in Japanese), the nature of their observations, nor do they indicate the extent of growth of the crystals. The writer can state from his own observations, however, that the change is not great, for rapidly frozen fish after a period of storage do not, on close visual examination but without a microscope, show any noticeable crystallization. The Japanese observers also state that, although the ice crystals in the tissues were very small, the muscle cells invariably suffered some damage. "For instance, if a slice of frozen flesh is cut off and immersed in cold water, the cell contents will soon dissolve out into the water, leaving the stroma substance something like cotton fiber. This was not the case with the flesh which was not frozen. By this means the fresh can easily be distinguished from the frozen flesh."

ACQUISITION OF UNDESIRABLE ODORS

Not only may fish in cold-storage rooms lose some of their natural flavor and odor, but they may also acquire foreign odors and flavors.

[19] H. F. Taylor, "Brine Freezing of Fish." U. S. Bureau of Fisheries Economic Circular No. 54. Washington, 1922.

[20] Z. Ogura and K. Fujikawa, "On the refrigeration and preservation of fish." Bulletin of the Government Fishery Experimental Station of Chosen, No. 1, 1925, 162 pp. (Japanese abstract in English, 8 pp.) Fusan.

The air of a cold-storage room is stagnant. No ventilation is provided, except that which is occasioned by opening the doors. Being in contact with fish continuously, it doubtless becomes charged with volatile substances from fish. If fish are stale when frozen, they have small quantities of ammonia, amines, hydrogen sulphide, and the like, which are volatile. Oxidation of fats produces aldehydes and other offensive substances, some of which are volatile. Smoked fish have a decided odor, which arises from the volatile constituents of smoke.

When large quantities and numerous varieties of fishes are stored together in an unventilated room the air may, and probably does, become charged with these volatile substances. Fish may absorb them to some extent. Round fish, well glazed, may not be appreciably affected, but fish without these protections, and especially those of slight flavor of their own, like haddock fillets and cod steaks, may be distinctly tainted with these odors. Protective wrappings for these products are necessary, therefore, not only to prevent drying out, but to prevent taint from foreign substances in the air. Low temperatures reduce the tendency to taint from the air, because the lower the temperature, the lower the tendency of volatile substances to evaporate, and the more completely they are condensed on the cold pipes along with the water. Smoked fish should be stored apart from other fish as far as possible.

This subject is of much practical importance, and has not been sufficiently studied. Steamship or railroad companies hesitate or refuse to forward fish in refrigerated compartments with meat, eggs, butter, and poultry. General cold storage warehouses either do not accept fish, or else store them in separate rooms, or, as in the case of the cold-storage warehouse of the Harbour Commissioners of Quebec, in an entirely separate building. Retailers usually avoid putting fish in their refrigerators along with other food products because of possible taint with fishy odors. Scarcely enough of this subject is definitely known to justify any broad generalizations. The writer has done some investigating and found that if an impervious covering is used, such as the various moisture-proof papers, and tight boxes, with low temperatures, taint may be reduced to a negligible amount.

CHANGES THAT DEPEND ON THE TEMPERATURE AT WHICH FISH ARE FROZEN

Generally, the colder the freezing medium the faster the fish freeze, and it has been shown already that the rapidity of freezing has much to do with the frozen product. Rapidity of freezing, however, can be had without excessively low temperatures by having good contact between fish and, say brine, and having the brine in rapid circulation. It has been shown that temperatures at which fish are frozen have an effect independent of the rate of freezing. The lower the temperature the more of the water is frozen out. The more water frozen out the more concentrated the remaining solution. At 104° F. below zero all the water is frozen out of the fish and the fish substance is completely dehydrated. It does not return to its original condition when defrosted. The implication of this

finding is that rapidity of freezing should be obtained by other means than excessively low temperatures.

CHANGES THAT AFFECT THE FOOD VALUE OF FISH

Among the changes already referred to that affect the food value of frozen fish the loss of juice caused by crystallization and the degradation of fats are the most important. The juice that runs out of a frozen fish on defrosting contains so much albumen that it coagulates like white of egg when it is heated. The fats, being partly oxidized, have lost part of their fuel value and interfere with digestion.

On devoting attention particularly to the protein constituents of fish, several chemists have found no significant changes that could affect food value.[21] Their conclusions are based largely on a study of the nitrogenous constituents. There is no doubt that changes that affect food value may and do occur in frozen fish, and that the seriousness of these changes depends on the methods of freezing and storage. That fish can be so frozen and stored that no important change will occur that would affect their food value is likewise well established.

DESIGN, CONSTRUCTION, AND EQUIPMENT OF FISH FREEZERS

The design, construction, and equipment of plants for freezing fish is a subject the adequate treatment of which is beyond the scope of the present work and must be left to refrigeration engineers, who are nearly always called upon where questions arise or plans for construction are to be made. However, a brief discussion of some aspects of the subject may be useful to the readers to whom this work is addressed.

LOCATION

Fish freezers should be located with respect to accessibility to boats that bring in fish, railroad tracks and wharves for cargo ships for transportation, an adequate source of clean water, and availability of coal or electric power and labor. A water-front location is most to be desired, of course, but it is not always available. The nearer to the point of actual production of fish that a freezer can be located the better in general, though public warehouses are located conveniently near wholesale fish markets. As large volumes of water are required for the condensers, it is economical to have access to a lake, river, artesian well, or other free water, which need not be highly pure, and also to filtered pure water for washing the fish.

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[21] C. S. Smith, "A study of the influence of cold-storage temperatures upon the chemical composition and nutritive value of fish." Biochemical Bulletin, Vol. III, 1913, pp. 54–68. New York. W. A. Perlzweig and W. J. Gies, "A further study of the chemical composition and nutritive value of fish subjected to prolonged periods of cold storage." *Ibid.*, pp. 69–71. E. D. Clark, L. H. Almy, and M. E. Pennington, "The commercial freezing and storing of fish." U. S. Department of Agriculture, Bureau of Chemistry, Bulletin 635, 1918. Washington. E. D. Clark and L. H. Almy, "A chemical study of frozen fish in storage for short and long periods." Journal of Industrial and Engineering Chemistry, vol. 12, 1920, pp. 656–663. Easton. L. H. Almy and E. Field, "Preservation of fish frozen in chilled brine. II. The keeping quality of the fish." Journal of Industrial and Engineering Chemistry, vol. 14, p. 203, 1922. Easton.

GENERAL FEATURES OF DESIGN

The freezer as a unit should be so designed that all parts are proportioned to the capacity desired. The sharp-freezer space should

FIG. 5.—Fish freezer of 14,000,000 pounds storage capacity at Prince Rupert, British Columbia

FIG. 6.—Freezer of brick construction and cork insulation, Bay City, Mich. Courtesy, Bay City Freezer

be calculated for maximum daily requirements, due regard being had for the frequency with which these maxima are likely to occur. In public warehouses, where the first month's storage includes the freezing charge, this first month yields more profit than succeeding months of storage. Quick turnovers are therefore desirable. In

private freezers, where the goods are held for a favorable market, the storage space may be the limit to the amount of business possible.

The sharp freezers, engine room, receiving, washing space, and clerk's office usually are located on the first floor. In some freezers in New England that freeze much herring for bait the receiving space is on the top floor and the sharp freezers are situated immediately under the receiving floor, in which several hatchways are provided. The herring are hoisted from the boats to the top floors, whence they are dumped through the hatches on wooden flakes in the sharp freezers.

The mistake frequently is made in freezer designs of allowing too little space for receiving, washing, panning, and other operations carried on in the open. Space may look large on a blue print but turn out to be too small when occupied by trucks, washing trough, empty pans, barrels, and boxes, when several men must work expeditiously, not only in washing and panning but also in packing and stenciling boxes.

The glazing room should be situated preferably on the route from sharp freezer to storage rooms. In many cases it is situated adjacent to the sharp freezers and serves a double purpose as glazing room and anteroom for the sharp freezers. In some cases it is on one of the upper floors. Ample room should be provided for shooks and, where advisable, a nailing machine.

In localities where conditions warrant it, a room held at about 32 to 35° for short-term storage of fresh, mild cured, and smoked fish, is profitable, often more so than the same amount of any other kind of space during the summer season. It is a common practice to provide such rooms with two or more sets of refrigeration coils. In winter months all coils are in use and the room is held at cold-storage temperature, while in summer part of the coils are closed, and enough are kept in use to provide a cool temperature. Because of the necessity of quick turnovers, often this room is on the ground floor.

Elevators should be of ample size and carrying capacity to accommodate trucks heavily loaded. Especial care should be exercised to have all elevator doors air-tight, because if not tight they permit a downward flow of the tall column of cold air in the shaft with consequent serious loss of refrigeration.

INSULATION

Some freezers are of frame construction insulated with sawdust. Lith and other materials frequently are used. Without a doubt cork is the most satisfactory insulating material we have. It is used best in connection with brick or concrete construction, though when properly protected with waterproofing materials is quite satisfactory in frame structures. Either excess or deficiency of cork insulation is false economy. Too little cork is wasteful of refrigeration and makes the maintenance of a proper temperature difficult. Where more than enough is used, depreciation and interest on investment more than equal the expense for refrigeration saved.

FLOORS

Floors in cold rooms generally are insulated. Usually they are waterproof and are designed to withstand heavy trucking. Those that are wet should be provided with floor drains connected with a sewer.

FIG. 7.—Conveying machinery in a fish freezer. The pans of fish are placed on the roller conveyor at right. At the end of the conveyor, in background, they pass on a pair of scales (shown in fig. 8), where they are weighed. Courtesy, Brooklyn Bridge Freezing & Cold Storage Co.

LIGHTS

Electric wiring should be insulated to resist dampness that may accumulate heavily on a change of temperature. Pilot lights should be placed at conspicuous places outside the rooms, and the lights always should be turned off when not in use.

CONVEYING MACHINERY FOR LABOR SAVING

The opportunities for saving labor by the use of conveying apparatus appear to have been largely neglected in fish freezers. Elabo-

FIG. 8.—Conveying machinery in fish freezer. The fish pass on a roller scale platform. The weights are recorded on an adding machine. The fish then pass into the vertical conveyor to the top floor sharp freezers. Courtesy, Brooklyn Bridge Freezing & Cold Storage Co.

FIG. 9.—Conveying machinery in fish freezer. The fish pans pass down the roller conveyor in the sharp freezer, to be placed on the pipes. When frozen, they are again placed on the conveyor and pass out through an opening in the door in the other end to the glazing rooms. Courtesy, Brooklyn Bridge Freezing & Cold Storage Co.

rate conveying apparatus has been installed in the plant of the Brooklyn Bridge Freezing and Cold Storage Co. in New York.[22]

Here the fish are panned at a long washing and panning trough on the ground floor, the pans being placed on a roller conveyer that conveys them toward a pan elevator in the rear of the building. On the way to the vertical hoist they pass over platform weighing scales. A man stands at the scales and notes on an adding machine the weight of each pan. The pans then go on the continuous vertical hoist that carries 8 to 9 pans per minute to the top floor, where the sharp freezers are situated. From the hoist the pans move by gravity on another roller conveyer into the sharp-freezer room, where they are placed on the shelves by hand. In an anteroom at the front of

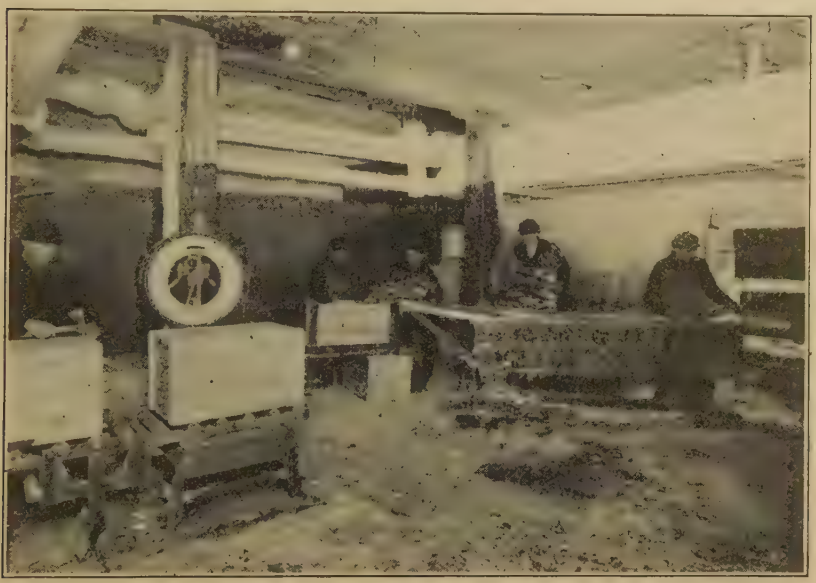

FIG. 10.—Conveying machinery in fish freezer. The pans of frozen fish emerge from the sharp freezer (right), are passed through the glazing pot, where the pans are removed from the cakes, glaze applied, and the cakes boxed and weighed. The boxes pass down a spiral chute to the storage rooms below. Courtesy, Brooklyn Bridge Freezing & Cold Storage Co.

the building the fish are glazed and boxed and conveyed by a gravity roller conveyer to a weighing scale, where the filled boxes are weighed. The roller conveyer then takes them to an elevator that carries them to the lower floors.

A similar plant, with automatic conveying machinery, nailing machines, and other labor-saving devices, is the fish-freezing plant that was built for the French Government on the Island of St. Pierre, Miquelon.[23]

In both of these freezers the fish are handled after panning only in putting them on and taking them off the shelves and in glazing and boxing.

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[22] For a description of this plant see Refrigerating World, vol. 56, No. 8, August, 1921. New York.

[23] Refrigerating World, vol. 56, No. 1, January, 1921. New York.

REFRIGERATION MACHINERY

Ammonia machinery is almost universally used in the United States for freezing fish. In some of the plants machines of the absorption type are used. While these are less efficient than compression machines for theoretical reasons, they are found in some excellent freezers. The loss of efficiency at low temperatures is relatively less than it is in compression machines, and the temptation to allow the temperature to rise is not so great. Therefore, though they are less efficient at all temperatures than compression machines, the very low temperatures necessary for the best freezing of fish are almost always maintained by them.

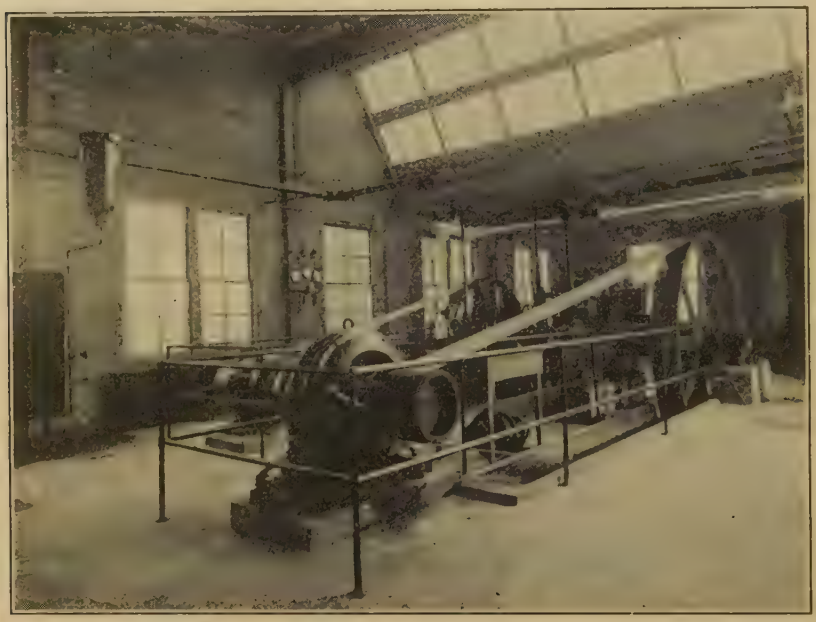

FIG. 11.—Refrigeration machinery, ammonia compression, electric drive. The electric drive is becoming more and more used. Where steam power is employed the compound Corliss engine gives a highly efficient service. Courtesy, Bay City Freezer

The two-stage compression machine that has come into use within the past few years is much more efficient than the single type at low temperatures. A large cylinder draws in the gas from the expansion element, gives it a preliminary compression, and passes it on to the final-stage cylinder of smaller diameter, where it is compressed to the condenser pressure. These machines approach the absorption machine in their maintained efficiency at low temperatures and are well suited to fish freezers.

For compression machines electric power is preferred; for absorption machines steam, of course, is necessary.

Many plants employ brine circulation, which gives more stable temperatures and permits easier regulation.[24] When brine is circu-

[24] For a compact and practical handbook of operating refrigerating plants see "Instructions for the care and operation of refrigeration plants." Department of the Navy, Bureau of Engineering, N. Eng. 144, revised edition, 1921. Washington.

lated, all the pipes are filled with the refrigerating medium and are therefore effective. In direct expansion systems a deficient charge of ammonia or improper regulation of the expansion valves may give rise to a condition wherein only a part of the piping is actually effective. For example, the writer has seen a sharp freezer heavily piped but with a temperature far too high. Examination revealed that all the ammonia admitted to the coils evaporated in three turns of pipe, and only these three were frosted. Further, really efficient operation of an ammonia machine requires skill, understanding, and watchfulness on the part of the operator. These qualities are more likely to be manifest if there is one expansion valve under his immediate care in the engine room than if several are located in various parts of the building. Another reason for preferring brine, especially in sharp freezers, is that the large volume of cold brine in the pipes prevents an excessive rise of temperature when the rooms are first loaded. The higher first cost of apparatus for brine circulation is justified in most cases by the more satisfactory operation.

Air washers, deodorizers, and dehumidifiers are not used and appear to be unnecessary in fish-freezing plants. Deficient rather than excessive humidity occurs in the rooms, but no satisfactory mechanical means has been devised for correcting this trouble. Drip pans sometimes are placed under the pipes but appear to be unnecessary, except in cool rooms kept above the freezing point of water; and even then, if the pipes remain frosted, they are not needed.

PRACTICAL FREEZING METHODS

FREEZING IN COLD ROOMS

As freezing in cold rooms is in almost universal use in the United States, the method will be described in detail, together with all necessary operations, some of which apply also to other methods that will be treated later.

RECEIVING AND INSPECTION

If the fish are received from the hold of a boat, usually they are hoisted mechanically to the platform. For salmon a satisfactory hoisting vessel is a wooden box lined with galvanized sheet iron. The ends of the box slopes outward and a rope is fastened by a hook in a ring at each end. When one end of the box is released on the platform and the other lifted, the salmon slide out easily and without impact. Halibut are hoisted by a 6-inch mesh cargo net woven of ½-inch manila rope, which, when caught by hooks at the corners, makes a large bag. This serves to hoist large quantities of halibut but seems to squeeze the fish against the ropes excessively. In most commercial freezers the fish arrive in boxes or barrels, iced. Immediately upon being landed western halibut are beheaded, the head portion is lifted with a meat hook, and the head is cut off with a butcher knife.

Before the fish are accepted they are, or should be, inspected for quality. It can not be repeated too often or too emphatically that this inspection should be severe. The temptation to save their fish

when they can is but natural among fish merchants, and they as naturally prefer to send them to the freezer rather than to the garbage dump when the exigencies of the trade make them unsalable for the time. Yet fish that are stale when frozen will not be less stale when they are defrosted. Every pound of off-quality fish that is frozen impairs the public esteem of frozen fish.

It is to be presumed that those in charge on the freezing platforms know the marks of fresh, old, or spoiled fish. General marks may be tabulated as follows:

GOOD FISH	BAD FISH
1. Odor of fish, fishy.	1. Odor stale, sour, or putrid.
2. Eyes bright, not wrinkled or sunken.	2. Eyes dull, wrinkled, sunken.
3. Gills bright red, covered with clear slime; odor under gill covers fresh, fishy.	3. Gills dull brown or gray, slime cloudy; odor under gill covers sour and offensive.
4. Colors bright.	4. Colors faded.
5. Flesh firm; in quite fresh fish the body is stiff; impressions made by fingers do not remain; slime present and clear (eels, halibut).	5. Flesh soft and flabby; impressions made by fingers remain; slime absent (halibut), slime cloudy, ropy (eels).
6. Belly walls intact.	6. Belly walls often ruptured, viscera protruding.
7. Muscle tissue white.	7. Muscle tissue becomes pinkish, especially around backbone.
8. The vent is pink, not protruding.	8. The vent is brown, protruding.

Many fish have marks of quality peculiar to them. Halibut often turn yellowish on the white side, the skin on the tail wrinkles when the tail is bent around, and the belly cavity becomes red and sour-smelling. Eels become covered with a white ropy slime. Such marks can be learned only by experience and careful observation. In some instances freezers, especially those conducted for private business, establish quality grades with more or less definite standards. In public freezers note is taken of the quality and entered in the records. One large private firm uses the following grades for halibut:

1. Perfect fish: White side not stained or colored; no cuts or wounds; black side bright; slime present and clear; blood bright, fresh red; fish firm and plump; smell sweet.

2. Fish of high grade but for a minor reason not in grade 1: As slime leaves body a yellow color spreads over white side; blood blanches and flesh becomes softer. These defects in moderate degree, slight wounds or gray spots on white side will cause halibut, otherwise excellent, to fall into grade 2.

3. As conditions described under 2 advance, the fish becomes slimeless and yellow, inside of belly cavity pink or stained; sour odor becomes evident; flesh soft, imprints of fingers remain; skin wrinkles when tail is bent; flesh lean or "loggy"; white side gray. Still fit for food but far from fancy.

4. Fish so far spoiled as to be unfit for food. If the inspector himself would not be willing to eat the fish they go in this class.

CLASSIFICATION OF TRADE SIZES

At the time of receipt fish are often sorted according to size, and there may be many size categories for one kind of fish. For example, in mackerel there are spikes, tinkers, medium, and large; bluefish, baby, small, medium, large; halibut, chicken, small, medium, large, whales. These are so numerous and varied that they can not be

given in a work of this scope. Fish that are panned and frozen in cakes are sorted during the panning operation. Fish that are frozen singly, like halibut and salmon, are sorted after the glazing operation.

In private freezers (especially for salmon and halibut on the Pacific coast, where the fish are purchased by the freezer) the fish are next weighed. For this purpose, two-wheel carts are provided, with the body lined with galvanized sheet iron and with the forward end sloping outwardly so that when dumped the fish slide out without violence. These carts are tared; with their load of fish they are rolled upon the scale platform and weighed.

DRESSING AND CLEANING

Fish freezers generally do not make a practice of dressing fish before freezing. In some cases this is done, especially in salmon. The salmon are dumped into a washing tank with fresh water running continuously. They are taken from the tank, beheaded, and gutted. The slit in the belly is sometimes made so as to leave the napes of the two sides connected (that is, the shoulder girdle bones are not separated). This prevents the fish from spreading open.

The belly membranes are rubbed out and the kidney (bloody organ in the belly cavity running along the backbone) is removed. For this work the operators use cotton gloves. In some instances hand brushes are used. The importance of removing the kidney and blood is overlooked frequently. It has been found that the blood of fish decomposes much more readily than the flesh of fish. If all the blood is removed carefully the fish will keep much better than it will if some blood is left. It is impossible to remove all blood if the kidney is left in the fish.

In public freezers fish usually are frozen as received—sometimes gutted, sometimes not. Salmon, halibut, and haddock always are gutted, and usually also medium and large bluefish, weakfish, and lake trout; mackerel, eels, smelt, butterfish, and the smaller pan fish are usually frozen round.

Apart from the desirability or undesirability of gutting as a trade practice, it deserves and has received some consideration as a question of sanitation and keeping quality. Green [25] investigated the subject; the following extracts from her memoir show her results:

(*a*) *Physical examination.*—Altogether about 50 gutted and ungutted fish were examined carefully, externally and internally, and comparisons made. Each fish was cut down the length of the spine and opened out like a kipper for inspection. Little difference in external appearance could be detected between gutted and ungutted fish, but much difference was apparent internally. Comparisons were best made after the fourth day at ordinary temperature.

The flesh of the ungutted herrings was still fairly white, firm, and in most cases free from any putrid smell. The muscle tissue immediately round the spine was inclined, on the whole, to be more bloodstained than was the case with the gutted ones, but in spite of this the flesh was firmer, whiter, and in better condition.

The flesh of the gutted ones, on the other hand, was much yellower and more discolored although not so bloodstained down the spine. They also had a very strong oily smell, which was completely lacking in the ungutted ones; in fact, the general appearance and smell of them was not nearly so good.

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[25] Ione H. Green, "Report of experiments on the cold storage of herrings carried out at North Shields [June and July, 1919]." Department of Scientific and Industrial Research, Food Investigation Board, Memoir No. 11, 6 pp. London, 1920.

(*b*) *Bacteriological examinations.*—A large number of fish-agar Petri dishes were inoculated with samples of muscle from gutted and ungutted herrings after four or five days at ordinary temperature, and comparisons were made of the amount of bacterial growth produced. The result was that in about two-thirds of the total number of plates the largest amount of growth came from gutted herrings. In view of the fact that the bacteriological samples were taken with extreme care in every case, and the muscle always taken from the same part of the fish, it was proved pretty definitely that more bacteria made their way into the muscle tissues of the gutted than of the ungutted specimens.

This result is due to the gutting process, wherein a large amount of gut contents are left behind upon the inner body wall; and although much of it is washed off in the brine tank, a large number of gut bacteria penetrate the flesh and start putrefaction more quickly than in the case of the ungutted fish, where the bacteria are imprisoned within the gut whose wall has first to be penetrated. Moreover, in the case of the gutted fish the inner as well as the outer surface is exposed to foreign contamination of all sorts, particularly after coming out of store, and this certainly hastens putrefaction more than when only the outer surface of the fish is open to infection.

It ought perhaps to be mentioned that the colonies produced on all the plates were chiefly of the same kind, namely, moist, round, buff-colored, fairly large, irregular-sized, Gram negative diplococci. All the plates gave off a strong smell of ammonia after the third day.

The strong smell of the fish referred to evidently was oxidation or rusting of the fat. The fish were kept at from 18 to 25°, which, of course, is far too warm to prevent rusting. These excessively warm temperatures may explain in large measure the difference she found.

This criticism applies to much of the otherwise valuable research work done in England and in Europe on freezing and cold storage of fish. The work of Plank, Ehrenbaum, Reüter, Stiles, Fortuyn, and others applies largely to freezing and storage at temperatures much above zero. It is well known in this country that satisfactory results can not be so produced.

WASHING

The commonest method of washing is to dump the fish, together with the ice in which they are packed, into a trough of water. This trough usually has a slat framework in the bottom and a standpipe for overflow of water. Usually water runs continuously into and out of the tank. Water serves to wash the fish and at the same time to remove the cracked ice. Sometimes the fish are roused about in the water with a wooden rake. When the washing consists in no more than putting a large quantity of fish into a small quantity of water and taking them out to pack them obviously it can do little good. The slime is tenacious and is the breeding ground of bacteria. Blood and pieces of gut are on and in the fish. The water quickly becomes a heavy culture of bacteria, which would do much more harm than good to a really fresh fish. Green (above referred to) says "finally, if fish, when gutted, can not be washed in *running* water they are far best left unwashed altogether."

Where a large volume of water is running vigorously and freely over and among the fish it does more good, especially in ungutted fish. There is also the question of washing off slime, which is not always desirable. A fresh eel, for example, if frozen with the slime on will look more natural after defrosting than it would if it had been washed thoroughly. It is the view of some, also, that the slime

constitutes a natural protection for the fish. These arguments have some force when applied to perfectly fresh, ungutted fish. In fact, if the fish could be frozen round immediately after coming from the water, without washing, they would be best of all; but after they have become infected heavily and have been gutted and contaminated with intestinal bacteria there seems to be no escape from the necessity of thorough washing, even though it does remove the slime.

Halibut when slimy are sometimes scrubbed with a brush before they are frozen. This practice is to be recommended, as old slime is of no value, and only serves to detract from the appearance of the fish. Eels should not be washed entirely free of slime. When

FIG. 12.—Washing. The fish in this case are in trays with slat bottoms. They are washed with a spray of water that runs through. In this freezer the wash water is maintained at 32° F., which serves to precool the fish. The fish may also be washed in the tanks, a more common practice. Courtesy, Bay City Freezer

perfectly fresh, the slime is desirable for the German smokers; but when the eels are a few days old the slime becomes ropy and unsightly and should be washed off. The glaze does not stick well over a heavy slime, but if not too heavy or ropy some of it may be left on by washing only lightly.

The water used for washing fish is usually, though unfortunately not always, pure, clean drinking water. The practice of using harbor, lake, or river water that has not been filtered or otherwise purified and that may contain bacteria that not only promote decomposition of fish but are a menace to health, is wholly bad. If there is any doubt about the quality of the water used, it is, of course, a duty that the proprietor owes to the public to have samples examined by a competent bacteriologist or the city or State board of health that has

jurisdiction. It is always best, where possible, to use the city water that has been purified for drinking purposes.

On the Pacific coast halibut are washed with a hose. In some freezers the halibut are laid out on the floor, white side up, heads all in the same direction. A strong stream of water is played on the fish by means of a hose and is directed as much as possible into the belly cavities. In other places each fish is raised from the floor and given a momentary squirt of water with a hose.

PANNING

Smaller fish nearly always are panned. (See fig. 7, p. 531.) Halibut, salmon, swordfish, and sturgeon are frozen without panning.

The practical advantages of packing the smaller varieties of fish in metal pans and freezing them in cakes have made the practice almost universal. By this means the fish are handled conveniently before and after they are put into the sharp freezer. The labor of handling and glazing the frozen fish is greatly reduced and simplified; boxes that would contain only about 125 pounds of singly-frozen fish contain 150 or more pounds frozen in cakes. In storage, exposure of the fish, as well as drying and rusting, is reduced. In shipment, breakage and abrasion are diminished. The disadvantages of pan freezing are that the rate of freezing is retarded because the surface of fish exposed to refrigeration is reduced. It has been shown already that rapid freezing produces better frozen fish than slow freezing does. The pressure of the fish against each other causes some distortion, and damage frequently is done to the fish when it is attempted to break a cake when only a part of it can be used at one time.

The pans are made of galvanized sheet iron, usually of 22 to 24 gauge. The size is not standardized, but custom has established a pan that ranges from 16 to 18 inches in width, 26 to 28 inches in length and 2½ to 3½ inches in depth. They hold from 25 to 35 pounds of fish. A typical example, taken from measurements made in a large freezer, has the following dimensions: Bottom of pan, 15¾ inches wide, 25 inches long; top, 17½ inches wide, 26¾ inches long; depth, 3 inches. The edges are of rolled wire.

Four ⅜ or ½ inch holes are made in the bottom of the pan to permit water and slime to drain off. In most freezers no lid is provided for the pans, in which case the sides of the pan slope outward, so the cake can be removed easily. In a few cases the sides of the pan are vertical and a lid is used to cover it. These lids keep drip out of pans that rest upon one another, keep "snow" from falling on the fish in the freezer, and undoubtedly prevent some loss of weight from drying in the freezer. Pans with lids have plain-cut edges.

The panning operation is most often done on tables attached by brackets to the side of the washing trough, usually 4 to 8 in number and about 2 feet apart. Moderate-sized fish are alternated, heads and tails, in one or more rows so as to fit nicely into the pans. Eels are bent around; large fish are arranged as orderly as possible. Some ingenuity is required to place the fish neatly. The heads point outward, if possible, so that the tails may be protected against

breaking off. Gutted fish are panned bellies downward, so that the water may run out of the belly cavity. Round fish are packed bellies up. Usually the fish are not panned in two layers, because a two-layer cake is difficult to break, if a part of the cake is wanted, without separating the whole. The bellies are left exposed, as the appearance of the belly of a fish is often indicative of the quality. Squid and butterfish are not arranged definitely in the pans but are dumped in promiscuously. Shrimp are better scattered thinly over the bottom of the pan, as otherwise they entrap so much air as to freeze slowly. Sometimes mackerel and shad roes are placed alone on the bottom of the pan, so that they can be wrapped separately after they are frozen. The time required for panning ranges from ½ to 4 minutes for each pan, depending on the size and style of arrangement of the fish and the skill of the operator. For example, a skilled worker can fill a pan of Spanish mackerel, small lake trout, or ciscoes in 1 to 1½ minutes. It is generally desirable to put as nearly as possible the same weight of fish in each pan, but nowhere are the pans weighed as they are packed. When the pans are filled, they are stacked on trucks, sometimes 8 or 10 deep. The pressure exerted on the fish in the bottom pans obviously does the fish no good and by crushing and bruising may promote autolysis.

FREEZING IN THE SHARP FREEZER

DESIGN AND CONSTRUCTION

Sharp freezers are usually small and several in number. The sizes most commonly found have a capacity ranging from 15,000 to 40,000 pounds at a charge. Usually they are long, narrow rooms, side by side, with doors at the ends.

Small rooms usually are preferred to large ones, because such rooms can be filled and left unmolested until the charge is frozen. In large rooms the temperature is more stable because of the large reserve of brine in the coils, but this advantage is offset by the disadvantage of frequent opening and closing of doors to put in and take out small lots of fish.

The side-by-side arrangement reduces the necessity for heavy insulation, except on outside walls, which should be covered with 6 or 8 inches of corkboard. It is always advisable to have storage rooms, glazing rooms, or chill rooms, rather than warm rooms or outside walls, adjacent to the sharp freezers. The same applies to rooms above and below the sharp freezers. Anterooms also are desirable to prevent excessive loss of cold air when the doors are opened. Sometimes a narrow corridor is built, into which all of the sharp freezers open. Often this is used as a glazing room.

PIPING IN SHARP FREEZERS

Along each side is a bank of refrigeration coils made of 1½ or 2 inch iron pipe, arranged to make shelves on vertical centers of 6, 8, or 10 inches. Direct-expansion ammonia or calcium-chloride brine from the refrigeration system circulates in these coils. If ammonia is expanded directly into the coils the expansion valves preferably

should be located at or near the low point of the coil, either inside or outside the room, and the coils kept well flooded with ammonia, with a trap to prevent the liquid ammonia from returning to the compressor. The "flooding" of the pipes with liquid ammonia secures the advantages of superior conduction of liquid in the coils as compared with gaseous ammonia. The "flooded" system, however, requires certain features of design and installation that, for the sake of safety, must not be overlooked.[26]

Where brine is used it is important to have a brisk circulation forced by an efficient pump. A mistake in arrangement of the circuits of pipe may greatly reduce the efficiency of the freezers. Where a main brine header is used, with many parallel circuits branching off, the flow of brine may be rapid in the header but slow in some rooms, especially when circuits in other rooms are open. This difficulty is avoided if the circuits are all in series, or, if more convenient, in two or three parallel series. When this arrangement is made, a by-pass connection is made to bridge each room coil, so that cutting off one room coil does not stop the flow through the entire system.

TEMPERATURE MAINTAINED IN SHARP FREEZERS

It has already been pointed out that the more rapid the freezing of fish the better. In fact, slow freezing is the one great defect in the method of freezing now being described and which is in common use. It is to be remembered also that the rate of freezing is proportional to the difference in temperature between the fish and their surroundings. If the fish on entering the freezer are at 32° they will freeze 50 per cent faster at 16° below zero than they will at 0°. The desirability of flooding the pipes with ammonia or briskly circulating brine is therefore of as much importance as the degree of temperature of the ammonia or brine, good insulation, and tight doors.

In this connection it is desirable to define what we mean by temperature of the air in the room. This temperature changes with the opening of doors and the loading and unloading of the room. When a freezer is filled with fresh fish and the door is closed the temperature rises because the fish are giving up their heat to the surrounding air. As the air warms, the difference between its temperature and that of the brine pipes increases, and, according to our rule, the rate of absorption of heat by the brine increases. The brine, flowing at a constant rate, warms, and the difference between its temperature and that of the ammonia increases, again giving up heat faster, in accordance with the rule. The ammonia warms, and the pressure shown by the suction gauge in the engine room rises. These changes continue until the whole system is in equilibrium—heat is being given up by the fish as fast as it is being absorbed by the brine (or ammonia) in the pipes, and the machine removes the heat at this same rate. The temperature in the sharp freezer

[26] See H. Rassbach, "The value of the flooded system, and its application to ice making and refrigerating plants." Paper read before the American Society of Refrigerating Engineers, Chicago, Oct. 18 and 19, 1909. Also published as Bulletin, L. A., by the Vilter Manufacturing Co., Milwaukee, Wis.

will now remain approximately constant for some time; that is, until the fish are so frozen that they give up heat at a diminishing rate. Then a series of changes in the opposite direction occurs. The brine pipes absorb heat from the air faster than the fish give up heat; the air becomes colder. The ammonia absorbs heat faster than the brine gets it from the air, so the brine grows colder, likewise the ammonia, and the pressure on the suction gauge drops. This continues until the fish are frozen through and until there are only small differences in temperature all around. The temperature at the finish may be 10 or 20° below zero, but it is not proper, for practical purposes, to call this the temperature of the room. It would do the fish no good to cool them to 50 or 100° below zero after they are frozen; in fact, there is little doubt but that it would do them harm. The important thing is not how cold they are eventually, but *how fast they freeze.* As the rate of freezing, as we have seen, is determined by the difference between the temperature of the air and the temperature of the fish while the freezing is going on, we may say that the speed with which they freeze is determined by the coldness of the air around them *while they are freezing.* The temperature of a sharp freezer thus may be defined as the maximum, approximately constant, temperature of the room after it has been loaded and the doors have been closed.

Failure to understand this principle often leads to difficulties and poor operation. A case that recently came to the writer's attention may well illustrate the point. A new freezer, approaching its maximum fish production of the season, contains a room with piping designed for a storage temperature of about 0°. When closed and empty it had a temperature of about 5° below zero. The management, anticipating a shortage of freezer space, reasoned that as a temperature of 5° below zero was as good as that of a sharp freezer (when it is loaded) the room might be used as a sharp freezer during the rush of fish production by the aid of wooden frames for the pans of fish. The management was surprised, of course, to find that the temperature of the loaded room rose many degrees above zero, and that the fish froze very slowly and were greatly damaged thereby. There was not enough pipe in the room to absorb the heat from the air as fast as the air absorbed it from the fish. The air grew warmer, the difference between the temperature of the air and that of the fish diminished, and the rate of freezing was retarded. This brings out another important rule; namely, each square foot of pipe surface absorbs a definite number of thermal units per hour per degree of difference in temperature. Under the conditions pevailing in a sharp freezer this figure is about 5 B. t. u. From 25,000 pounds of fish approximately 3,480,000 B. t. u. must be removed in order to freeze it, and the required number of square feet of pipe surface must be available to carry this amount of heat away in the given time.

On the basis of this definition we have few exact data regarding the degrees of temperature maintained in sharp freezers. Final temperature in freezers ranges as low as 20° or 25° below zero, and during the heavy load it runs as high as 20° above zero. The temperature actually prevailing at any time in the sharp freezer depends on the piping, temperature and rate of flow of brine, quantity and initial temperature of fish, insulation, opening of doors, air circula-

tion, etc. It is highly desirable to maintain a maximum temperature not above 0° F. during the freezing process.

There are also few data on the amount of time required to freeze fish in air. Pans of fish usually are allowed to remain on the sharp freezer for 24 to 36 or even 48 hours when the temperature is not low. Panned fish, small, and large fish freeze in about the same length of time, but if frozen separately small fish freeze much more rapidly than large ones.

In rooms refrigerated by direct expansion it is a common practice to stop flow of the ammonia while the rooms are being loaded. After the fish are on the shelves the doors are closed and the expansion valves opened. The room begins to cool and reaches a fairly constant temperature at several degrees above zero, where it remains for several hours, until the fish are nearly frozen. The temperature then drops gradually until it reaches, say, 10° below zero, when the fish are considered to be frozen. The ammonia is again turned off and the fish taken out. If the doors are left open, the snow on the coils thaws and there is much drip. The coils, being clean, absorb heat faster but also appear to take up moisture faster.

In rooms refrigerated by brine the brine is allowed to run continuously and the rooms are always cold. In such a case freezing begins at a lower air temperature and probably progresses more rapidly. As the snow on the pipes rarely thaws, it becomes very dirty from drip from the pans. It should be removed occasionally by shutting off the brine and warming up the room, or by an accessory circulation of warm brine through the pipes.

PLACING THE FISH IN THE SHARP FREEZER

In most cases the fish are trucked into the freezers, where the pans of fish are transferred from truck to coils. Sometimes a small door is let into the large freezer door, through which the fish may be passed without entailing a great loss of cold air. A few freezers have a roller conveyer leading from this small door along the corridor of the freezer. Operators receive the pans from the roller conveyer and place them on the shelves. (See fig. 7, p. 531.) The pans should rest directly on the coils. Sometimes, when freezer space is limited the pans are placed one on another; but this practice is obviously bad because, it will be remembered, the heat must pass out through the surface of the fish. Stacking pans two deep eliminates the bottom of one and the top of the other as available surfaces—nearly half the total surface—and retards freezing in the same proportion.

For large fish, where pans are not used, there are provided galvanized-iron sheets that are laid on the coils. (Fig. 14.) The fish are laid on these metal sheets in such a way that they do not freeze together. Still larger fish, such as whale halibut, swordfish, and sturgeon, are laid on the floor or on boxes or battens to freeze or else they are suspended. Large fish like these freeze in 2 to 4 days at a sufficiently low temperature.

Herring for bait are not panned but are dumped en masse on wooden flakes. If on iron sheets they stick and are difficult to remove.

Shucked oysters in 1-gallon tin cans are simply placed in the sharp freezers on the shelves or floor and allowed to freeze. Clams and scallops are treated in the same manner, the latter sometimes being frozen in muslin bags.

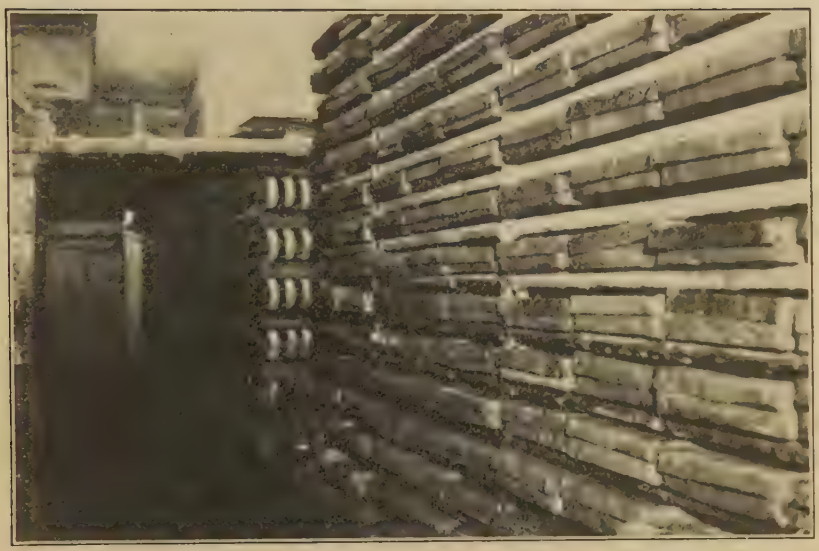

FIG. 13.—Fish pans in sharp freezer. In this freezer the pans are fitted with lids. Courtesy, Booth Cold Storage Co.

FIG. 14.—Salmon being individually frozen. The pipe shelves are provided with sheets of galvanized iron on which the fish are laid. Courtesy, Canadian Fishing & Cold Storage Co. (Ltd.)

Circulation of air, especially if rapid, greatly facilitates the freezing of fish. Halibut weighing about 15 pounds, suspended before a large fan in the sharp freezer at 9.5° below zero, froze in 3½ hours. Another experiment with a long wooden tube 2 by 2 by 12 feet long, with a fan at one end and fish suspended in the tube, gave interesting results. The air temperature was 10° below zero. Whitefish nearest the fan were frozen in one-half hour. The air passing over the fish was warmed rapidly, so that fish at the opposite end of the tunnel required three hours to freeze. At 7° above zero smoked fillets of haddock before a fan froze in 30 to 40 minutes, according to the distance from the fan. The nearest were 6 inches from the fan and the farthest about 18 inches. This method of freezing dries the fish excessively, and, because of the large volume and high velocity of air necessary, seems impracticable for commercial use. About 33 cubic feet of air are equivalent in cooling power to 1 pound of brine. The preferred practices to be recommended in the freezing of fish in sharp freezers may be summarized thus:

1. The sharp freezers should be adjacent to each other or to other cold rooms, and exposed walls, floors, and ceilings should be heavily insulated.
2. Tight doors should be provided, and the air circulation should be locked with anterooms.
3. Fish are preferably passed into the freezers through small doors in the main doors.
4. The freezers should be very heavily piped.
5. If ammonia is directly expanded in the pipes the latter should be kept flooded with ammonia.
6. If brine is circulated in the pipes, pipe circuits should be so arranged and pump capacities provided to give very brisk circulation.
7. The rooms should be cold when the fish are put in.
8. The fish in pans should not be stacked, but each should rest directly on the pipes.
9. The temperature of the air in the room should, if possible, never be higher than 0°.
10. To obtain the proper temperature of the room the brine should be at from 10° to 20° below zero.

GLAZING

When frozen fish are to be stored, they are exposed more or less to the air. If they are not protected, the oxygen of the air will act on the fats, turning them rancid, and the moisture and perhaps odor and flavor principles will evaporate. To protect the fish from these untoward happenings they must be glazed; that is, the frozen fish must be dipped in cold water, some of which adheres and freezes as an envelope or glaze of ice, completely surrounding the fish.

REMOVING CAKE FROM FREEZING PAN

Fish that have been frozen in metal pans stick fast and must be warmed slightly by spraying with or immersing them in water to loosen them. In most cases this is done in one operation by passing the pan containing the frozen cake into the glazing bath. (Fig. 10, p. 533.) In this bath the fish thaw just enough to loosen the pan, which is then taken off. The cake, remaining a moment in the water, is covered with a glaze and is then removed for boxing. When this operation is done carelessly the side of the cake that was on the bottom of the pan is not wetted and therefore not glazed.

In one freezer a rectangular shower bath is provided at one end of the glazing tank. The pan is passed, upside-down, under this bath,

and upon emerging from the bath the cake slides into the bath and the pan is removed at the same time.

GLAZING TANKS

The glazing trough usually consists of a shallow wooden tank, 6 or 8 feet long, with curved runners that pass under the water and out lengthwise of the tank. (See Fig. 10, p. 533.) In some tanks the

FIG. 15.—Improved type of glazing tank for salmon and halibut. The tank is of concrete. Courtesy, Seattle Port Commission

bottom is curved. The tank may be stationary or on casters. When no special room is provided for glazing, a movable glazing tank is placed near the sharp freezer doors.

On the Pacific coast, where halibut and salmon are frozen in large quantities, the glazing tank in common use is a stationary wooden or concrete tank provided with a movable wooden slat plat-

form suspended by ropes to a windlass or lever, by which it is moved up and down in the tank. (Fig. 15.) The salmon or halibut are piled on this suspended platform, which, when loaded, is lowered into the water. One to four dips are given, separated by a moment out of the water for draining off excess water and freezing the glaze. An improvement on this type of glazing tank is a concrete tank partly below the floor level. Instead of the wooden platform a large rectangular, heavy, galvanized-wire basket is suspended by a one-half-ton electric hoist. (Fig. 15.) The hoist rides on trolleys on an overhead rail leading from the sharp freezers to the glazing room and from the latter to the elevator, and into the several storage rooms. The wire basket is loaded in the sharp freezer, conveyed into the glazing room, lowered into the water by means of the electric hoist,

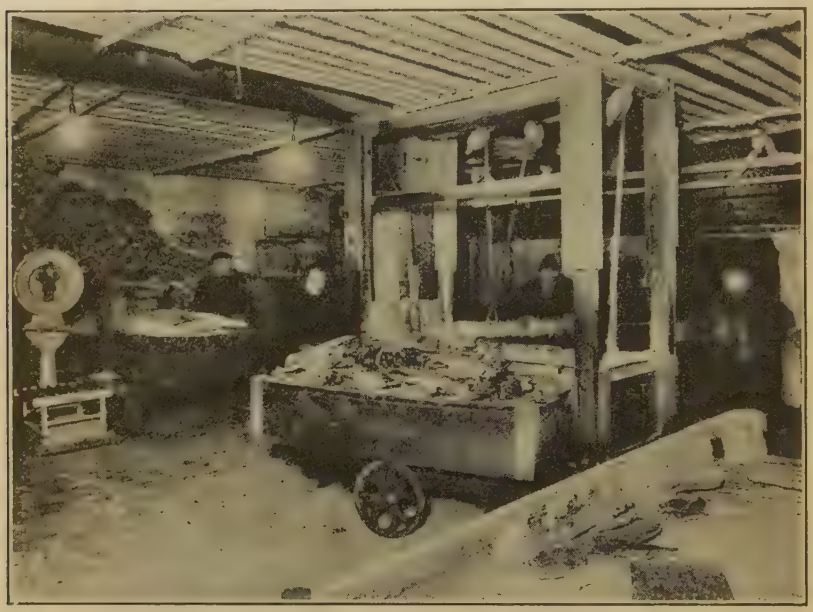

FIG. 16.—Glazing room of a Pacific coast freezer. Halibut, black cod, and salmon are being glazed in the dipping tank. Roller platform scales at left for weighing the glazed fish. Courtesy, Canadian Fishing Co. (Ltd.)

then raised and conveyed to the elevator and into the storage rooms. From 500 to 750 pounds of fish are handled at a load.

TEMPERATURE OF GLAZING ROOM

A fish that is not thoroughly frozen will not glaze properly, especially in warm air, because the fish is of itself not cold enough to freeze a good glaze. A simple calculation will illustrate the point. A 2-pound fish will take, say, a 5 per cent glaze. Assume that the glazing water is at 35°. The fish is 80 per cent, or 1.6 pounds, of ice. As the specific heat of ice is 0.5, then 0.5×1.6, or 0.8 B. t. u., is required for each degree of increase in temperature of the fish. One-tenth of a pound of glaze is frozen on the fish, requiring 14.4 B. t. u. of latent heat and 0.3 B. t. u. to cool the water from 35 to 32°, or 14.7 altogether; $14.7 \div 0.8 = 18.4°$ rise in temperature of the fish to freeze the

glaze. This calculation is only illustrative, however, and does not necessarily represent what actually happens within the fish. It is more probable that at the beginning not all the water in the fish is frozen; the ice present is in equilibrium with concentrated fish juice. As the fish absorbs heat from the freezing glaze, some of the internal ice thaws, absorbing latent heat, with a corresponding dilution of the juice and rise in temperature.

At any rate, it is much better to derive part of the refrigeration from the surrounding air for freezing the glaze. While glaze will form on the thicker parts of the fish in comparatively warm air by warming the fish, the thin parts—fins, tail, and snout—will not glaze at all, because these parts do not contain sufficient refrigeration. They can be covered with glaze only in air cold enough to freeze the water. The freezing point of water being 32°, it might seem that air slightly below this temperature would be sufficient; but water drains off rapidly when fish are withdrawn from the water, and at too high a temperature too much of the water runs off before it has frozen, consequently the glaze is thin. Several quick dips with short intervals between in the cold-room air are better than one long dip in the trough. These several dips allow freezing of the glaze partly by the cold air rather than entirely by the fish.

The temperature in the glazing room should be low, therefore, and might be very low as far as the glazing itself is concerned; but workers object to remaining for long periods in very cold rooms. A temperature of from 12 to 15° has been found to be satisfactory, producing a good glaze and being not too cold for the workers if they remain vigorously active.

It is contended by some that because when fish come from the freezer they are not of uniform temperature throughout, further freezing of the inner portions occurs after they are placed in the cold-storage room, which causes further expansion that cracks the glaze. They should not be glazed at once but allowed to come to a uniform temperature in the storage-room air before the glaze is applied. There may be something in this objection to the practice now followed, but it is academic, for it would be commercially expensive to store loose or boxed fish and then handle them all over again for glazing.

TEMPERATURE OF GLAZING WATER

The glazing water should be clean, wholesome water of 35 to 40° temperature. In some plants warmer water is used. If operations are begun with warm water, ice is added to cool it; in this case snow from pipe coils should not be used, as it forms a mush that sticks to the fish, making a rough surface. However, as glazing proceeds, the water is chilled rapidly by the cold cakes of fish passing through it. When the water approaches the freezing point, a pebbly glaze is produced. The water must therefore be kept slightly warmer, preferably at about 35° F., by the continuous flow of a small amount of warmer water into the glazing tank.

THICKNESS AND AMOUNT OF GLAZE APPLIED

The cakes of fish are left in the water for from a few seconds to a minute at a time. It is inadvisable to leave them in longer. The con-

ductivity of the fish is not any too good, and the fish is surrounded by water warmer than itself. The heat given up by the water in freezing is taken up by the outer part of the fish, but is conducted inward rather slowly, so that if the fish is left in the water too long the outer part of it is thawed. It is better to lift the fish out of the water in order to give the heat time to be conducted into the interior of the fish and also, if the air of the room is cold, to take advantage of the refrigeration in the air. If a thicker glaze is required, the fish may be dipped a second or third time. Excessively thick glaze is usually undesirable because customers may object to the undue increase in weight; and, also, too thick a glaze may crack on handling. The ideal glaze is clear, smooth, comparatively thin, free from roughness, and uniformly adherent to all parts of the fish, including snout, fins, and tail. The ice glaze usually has bubbles or tubular holes in it, probably caused by the air dissolved in the water. Water heated to the boiling point to drive off the air and then cooled off probably would produce a better glaze.

Tables 7, 8, and 9 give some idea of the amount of glaze put on fish. In general, it varies from 2 to 7 per cent. Fish frozen singly take a larger percentage of glaze than pan fish take, because there is more surface to be glazed. Small fish, individually frozen, take a larger percentage than large ones for the same reason. Soft, smooth fish, like eels, mackerel, and lake trout, take a better and heavier glaze than heavily scaled fish, like carp, drum, or red snapper, because heavy scales act as insulators, preventing the water from freezing quickly. Table 9 gives the amount of glaze on several individual cakes of squid, showing that, though the average amount of glaze is 2.5 per cent, that on the individual cakes varies from 0.8 to 3.9 per cent. It would be desirable for trade reasons to make cakes of uniform weight and glaze, but so far this has never been accomplished in practice.

TABLE 7.—*Glaze on blue pike, cakes frozen in pans*

Weight of cake—				Amount of glaze		
Before glazing		After glazing				
Pounds	*Ounces*	*Pounds*	*Ounces*	*Pounds*	*Ounces*	*Per cent*
33	0	34	1	1	1	3.1
39	12	41	1	1	5	3.2
34	9	36	3	1	10	4.5
38	14	40	3	1	5	3.3
33	14	34	15	1	1	3.0
38	0	38	13	0	13	2.1
34	9	35	12	1	3	3.3
38	8	40	3	1	11	4.2
38	12	39	13	1	1	2.7
Average						3.4

Halibut usually are trimmed before they are glazed. The side fins are chopped off with a large butcher knife or sharp hatchet, and the nape usually is smoothed with a little trimming. As will be seen in Table 9, the loss of weight in the trimming is about the same, on the average, as the amount of glaze, so that an untrimmed, unglazed halibut weighs about the same as a trimmed and glazed one. Fins

if left on do not glaze well, dry out rapidly in the freezer, and act as a wick to draw out the moisture from the adjacent tissues.

TABLE 8.—*Gain in weight on glazing squid*

Pan No.	Weight frozen		Weight glazed		Gain in weight		
	Pounds	*Ounces*	*Pounds*	*Ounces*	*Pounds*	*Ounces*	*Per cent*
1	35	0	35	12	0	12	2.1
2	33	8	34	8	1	0	2.9
3	34	0	35	0	1	0	2.9
4	30	0	30	12	0	12	2.5
5	35	12	36	4	0	8	1.4
6	32	8	33	4	0	12	2.3
7	31	12	33	0	1	4	3.9
8	32	8	32	12	0	4	.8
9	33	4	34	4	1	0	3.0
10	30	12	31	12	1	0	3.2
11	40	0	41	0	1	0	2.5
12	25	8	26	8	1	0	3.9
13	27	8	28	8	1	0	3.6
14	33	0	33	8	0	8	1.5
15	35	0	35	8	0	8	1.4
16	29	0	30	0	1	0	3.4
17	32	0	32	8	0	8	1.5
18	32	8	33	0	0	8	1.5
19	27	8	28	0	0	8	1.8
20	25	12	26	8	0	12	2.9
21	25	8	26	8	1	0	3.9
22	34	8	35	8	1	0	2.9
Average							2.5

TABLE 9.—*Trimming and glazing halibut*

No.	Weight frozen		Weight after trim		Loss in trim			Weight glazed		Amount of glaze	
	Pounds	*Ounces*	*Pounds*	*Ounces*	*Pounds*	*Ounces*	*Per ct.*	*Pounds*	*Ounces*	*Ounces*	*Per ct.*[1]
1	16	15	16	4	0	11	4.1	16	14	0–10	3.7
2	15	11	15	2	0	9	3.6	15	12	0–10	4.0
3	13	10	13	3	0	7	3.2	13	11	0– 8	3.7
4	14	6	13	11	0	11	4.8	14	5	0–10	4.3
5	26	5	25	5	1	0	3.8	26	0	0–11	2.6
6	16	0	15	7	0	9	3.5	16	2	0–11	4.3
7	21	11	20	14	0	13	3.7	21	11	0–13	3.7
8	31	9	30	4	1	5	4.1	31	4	0– 6	1.2
9	23	3	22	4	0	15	4.0	22	14	0–10	2.6
10	14	13	14	7	0	6	2.5	15	1	0–10	4.2
11	24	15	24	2	0	13	3.2	24	13	0–11	2.7
Average	19	15	19	3	0	12	3.67	19	14	0–10	3.36

[1] Based on original or unglazed weight.

OTHER PROTECTIVE GLAZES

Materials other than ice have been used to cover fish, but apparently without commercial success. Paraffin has been tried, but is too brittle at low temperatures and can be applied in a perfect film only with great difficulty. Another substance tried with more success in Germany is called "Jela," a proprietary mixture of linseed oil, resin, paraffin, and carnauba wax. It is more flexible and more easily applied than paraffin, and undoubtedly keeps the surface of fish in almost perfect condition during long periods of storage. Being impervious to water and air, it prevents the slow evaporation, oxidation, and absorption of cold-storage odors that take place where impervious

protection is not used; but at best it is expensive and troublesome to apply.

Gelatin in 3 or 4 per cent solution has been tried. This holds the moisture even when the fish is defrosted, but is not impervious to water or to gases soluble in water. While the gelatin film remains on the fish water can diffuse through it slowly and evaporate. Tests recently made with a gelatin glaze indicate that it offers no advantages.

BOXING, MARKING, AND WEIGHING

Before frozen fish are placed in the cold-storage room they are boxed or not, as the case may require. Boxes, as will be seen later, afford a certain amount of protection to fish and make for more expeditious handling. Breakage of fins, tails, and snouts is prevented, and drying and rusting are not extensive. Boxes also provide an easy means of marking weights, dates, names, and lot numbers. Boxed fish also are more economical of space, for they make it possible to fill to the ceiling a room that otherwise could not be so filled with assorted varieties and lots for which bins would have to be built. Pan-frozen fish usually are boxed, especially in public freezers. Large fish, such as halibut, salmon, carp, sturgeon, cero, king mackerel, red snapper, cod, and shad, which are frozen singly, often are stored unboxed. The maximum economy of space is attained in private freezers where pan-frozen fish are stored not boxed, the rooms being filled entirely with the cakes, closely stacked.

BOXES

The boxes are made of any suitable wood—spruce, pine, fir, etc. They are generally constructed as the "Style 4" standard of the box manufacturers. This style has the cleats on the ends of the boxes and is preferred because, when the boxes are stored on end, the cleats serve as battens to keep the boxes separated by spaces in which the cold air can circulate. Salmon and halibut boxes to be used for long-distance shipments usually are reinforced with a triangular strip nailed in the corners. For packing cakes of pan-frozen fish the boxes are made of a size just large enough to accommodate 4 or 6 cakes—that is, 100 to 150 pounds. Some inside dimensions of boxes in use are as follows:

TABLE 10

Length, inches	Width, inches	Depth, inches	Capacity
26.5	16.5	16	Four to five cakes.
26.5	14.25	18.5	150 to 165 pounds, winter-caught fish.
27	17	17	150 pounds cake frozen fish.
34.5	18	9.75	California shad.
51.5	25	16.5	Western halibut.

The thickness of wood is $\frac{3}{8}$, $\frac{7}{16}$, or $\frac{1}{2}$ inch in the smaller boxes and $\frac{3}{4}$ or $\frac{7}{8}$ inch in the larger ones. In public freezers, where each lot of fish must be kept strictly intact, use is made of shallow extra, or "ex" boxes. These are made to fit one, two, or three cakes of

pan-frozen fish and to accommodate odd numbers of cakes left over from the larger standard boxes.

The boxes usually are bought as shooks for convenience in shipment and are stored in a convenient dry room, attic, or shed. Nailing machines sometimes are used in the larger freezers, but in many freezers the management finds that fluctuations in the volume of business often leave the laborers with little to do, at which times they can be turned to nailing boxes by hand. The boards are nailed together as snugly as possible to avoid air circulation between the inside and outside. The boxes cost, in shook form, of North Carolina pine, from 40 to 55 cents each, in carload lots. White-pine boxes are considerably more expensive.

WRAPPING FISH AND LINING BOXES

Some fancy varieties of fish, such as mackerel, salmon, and whitefish, are wrapped with vegetable parchment paper before they are packed. The wrapping improves the appearance of the fish and may carry a printed trade-mark or advertising matter. It is further useful in protecting the fish from drying and rusting. Sometimes, usually for export, the boxes are lined with vegetable parchment paper. Parchment is used because it resists the action of water when the fish defrost. This lining paper also may bear a printed trade-mark. Fancy grades of frozen salmon and halibut are sometimes labeled individually. A paper label, not gummed, bearing the trade-mark, guarantee, and name of the producer, is wetted and applied to the side of the fish before the latter is glazed. After the glaze is applied the label can not be removed without damaging the glaze or defrosting the fish.

PRECOOLING AND WETTING BOXES

In freezers where the best and most careful work is done the boxes are wetted before they are filled and are also precooled for several hours in a cold room. The weighing and packing is done in the glazing room or other cold room. A dry box absorbs some of the moisture from the fish, but if it is wet the absorbed water later freezes, to make an icy box that helps substantially to reduce drying. By packing and weighing in a cold room a low temperature of air in the box is assured at the start, though this factor is of comparatively little importance because of the very low heat capacity of the small quantity of air in the box.

WEIGHING AND MARKING

The customary weight of fish in a freezer is the frozen weight. This, of course, is usually greater than the fresh weight because of the glaze. As the boxes are of approximately uniform weight, the boxes are weighed after they are packed and closed, and the tare weight of box is deducted from the gross to give the net weight. The gross, tare, and net weights are then marked or stenciled on the box, together with the lot number and date, variety, and size of fish, which are stamped on. Box numbers, where they are used, also are stenciled on. These markings are put on the end of the box. Some

freezers put the markings on both ends for convenience. Trade-marks are put on the sides.

In several of the States there are cold-storage laws that regulate the conditions of storage of fish. Most of them prescribe a limit to the length of time frozen fish may be kept in storage, and it is for this reason that it is important that these markings be accurate and plain.

For shipment, boxes are greatly strengthened by strapping with metal straps or tying with wire. For tying with wire handy and efficient little machines are available that tie a box in a few seconds. For export the steamship companies require that the boxes be strapped or wire-tied.

FREEZING IN ORIGINAL CONTAINERS

Some fishery products are frozen in the wooden boxes or other containers in which they were originally packed. Finnan haddies, smoked fish, smoked fillets, squid, pulpo or octopus, and smelts often are placed directly in the cold-storage rooms without the advantages of the lower temperature of the sharp freezer. Examination of the frozen products shows that such products, especially the fillets (smoked or fresh), are seriously injured by internal crystallization when frozen by this method. Smelts do not seem to be injured so much by this treatment.

STORING FROZEN FISH

The very best quality in fish after it has been frozen, stored, and finally defrosted can be expected only if the best practice has been followed throughout the entire process, at each stage of which poor practice may easily result in more or less serious impairment of quality. While it may be true that the freezing proper is the most important stage of the process, holding more possibilities of injury or good preservation than any other, it is only little more important than the methods followed in storage; for many pounds of fish reach the storerooms in excellent condition, only to emerge dried, rusty, and insipid. Good storage is much more than merely putting frozen fish in a room below freezing in temperature and keeping them there until they are wanted. Activities if not prevented will be going on slowly but steadily 24 hours a day, until in a few months the best edible qualities have departed and a mere dry and fibrous ghost of the original fish remains.

Briefly stated, the two great enemies of frozen fish in storage are rusting and drying; the principal combatives are low temperature and heavy glazing. Low temperature arrests rusting and promotes drying; glazing, aided by other protective means, prevents drying and helps to prevent rusting. These have been the governing factors in the development of methods of storage now practiced. Some reference books on refrigeration give the "proper" temperatures for storing different varieties of fish, and the idea seems to prevail elsewhere that different kinds of fish require different storage temperatures. General experience in cold storage as now practiced indicates that the temperature should be as low as is possible and economical for all kinds of fish, preferably from 0° to 5° F. The

temperature is not likely to be too low, as far as the quality of the fish is concerned, provided they are protected from drying and the temperature remains constant.

Cold-storage rooms are usually large and are located on the upper floors of the house. They are insulated, of course, in keeping with the temperatures to be maintained—usually 4 or 6 inches of cork, or the equivalent insulating value in other materials. The piping usually is suspended from the ceiling or placed on the side walls, or both, and in ample amount to insure the required low temperature.

FIG. 17.—Storeroom of boxed frozen fish. Here the boxes are stacked on bottoms. It is more general practice to stand the boxes on end. When Style 4 boxes are used and stacked on end the cleats separate the boxes and allow circulation of air between them. Courtesy, Bay City Freezer

The walls usually are whitewashed. Freshly applied whitewash, however, appears to have a drying effect on fish placed near it.

TEMPERATURE OF STORAGE ROOMS

It has been pointed out already (see Glazing, p. 546) that low temperature is the only sure means of avoiding rust or rancidity of fat fish, though a heavy glaze helps. The approximate maximum temperature is 8° F., if the fish are to be kept more than three or four weeks. It is safer to maintain 5° or even 0°, as some of the best freezers do regularly. Even at these temperatures some fish, particularly prone to rust, such as smelts, may rust unless they are otherwise protected.

Although there seems to be no mention of it in the scientific literature of fish cold storage, there appears to take place a change in the

protein of fish on long cold storage, called "souring" by the practical freezer man. The activities of bacteria are greatly retarded by freezing but apparently are not absolutely arrested, for some fish on long storage develop a sour odor. Pickerel, especially if frozen

FIG. 18.—Storage room in a public freezer. For separately frozen fish, not boxed, bins are provided to keep the lots separate, so that they are accessible for delivery at any time. Tags for lot numbers and dates are attached to each bin. Courtesy, Brooklyn Bridge Freezing & Cold Storage Co.

round, are prone to sour and may do so in a few months at 0° F. Ciscoes also are subject to this trouble, especially if round, but the trouble is slow to develop. Perhaps the intestines or contents of the alimentary canal are chiefly concerned in souring.

The temperature must not only be low but also as constant as possible. Fluctuating temperature promotes drying of the fish. The

vapor pressure (that is, the tendency to evaporate) of water or ice increases with rising temperature. The tendency of water vapor to condense increases with a lowering temperature. Water will evaporate, therefore, from warm objects and condense on cold ones. The pipes are usually the coldest objects in the room—perhaps several degrees colder than the fish. The ice slowly evaporates from the fish and condenses as snow on the pipes. When the temperature of the room and the fish rises a few degrees temporarily, evaporation is increased. Therefore, provision is made to prevent warm air from entering the storage room when the doors are opened. Sometimes a canvas curtain is used at doors and elevator openings. The brine or ammonia is kept at a temperature as nearly uniform as possible.

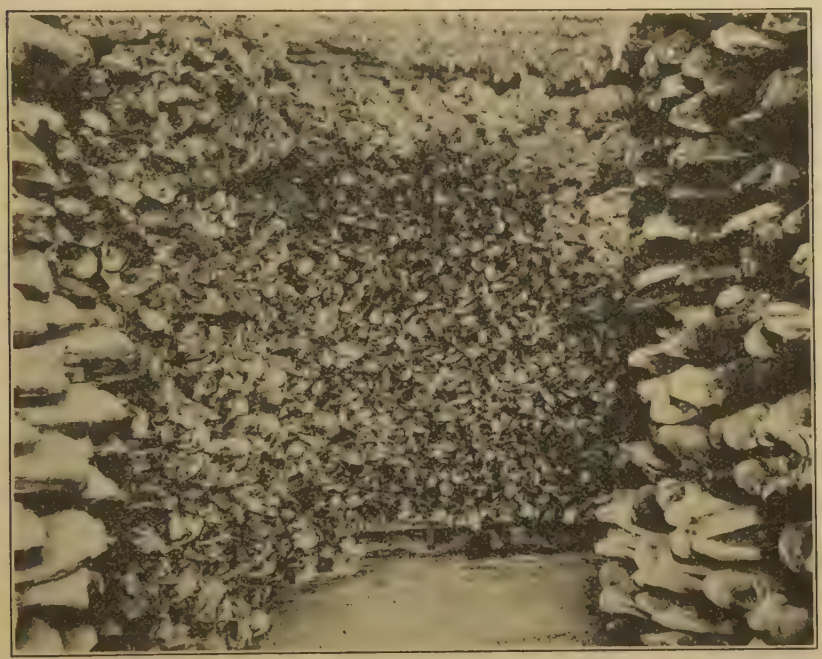

FIG. 19.—Halibut and salmon frozen and stored in bulk in a private freezer, Pacific coast. Courtesy, Canadian Fishing Co. (Ltd.)

PLACING FISH IN STOREROOMS

In public freezers, where the fish are boxed, the boxes are placed in the rooms, usually standing on end, and stacked to the ceilings. Dunnage is often, though not always, put on the floors to permit circulation of cold air under the boxes. Bins usually are built for fish not frozen in cakes. Such bins serve to hold the fish and to keep lots separate. Bait herring are dumped without arrangement into large bins.

In private freezers, especially those used chiefly for halibut and salmon, the frozen fish are stacked in an orderly way without boxing. One method of arrangement is to put dunnage on the floor, then pile the fish to the ceiling in a solid rectangular block, leaving only a

narrow passageway adjacent to the four walls for inspecting and reglazing. The tails all point inward and heads or shoulder ends outward. Halibut are piled white side up, except the four or five nearest the top, which are arranged black side up. Another arrangement is to stack the fish, filling the room completely, with a wooden framework placed near the wall pipes to hold the fish away from the pipes. A space is left so that the door may be opened. It is best to arrange the fish so that all those exposed to the air will be accessible for reglazing. When rooms are so filled, the fish well glazed, the doors kept closed, and the temperature kept at 0° or thereabouts, the conditions for keeping are excellent. This solid formation of loose fish economizes space and obviates a larger investment for boxes.

REGLAZING

As already stated, exposed fish in a cold room gradually dry. The glaze first evaporates; then the skin, fins, tail, and snout become dry. The following tabulation, taken from Ehrenbaum and Plank [27] illustrates the rate at which certain fish, hanging free, will dry at a storage temperature of 19.6° F.

TABLE 11.—*Loss of weight of glazed fish hanging in a storage room at 19.6° F.*

Fish	Original weight	Loss of weight—							
		After 10 days	After 20 days	After 40 days	After 60 days	After 80 days	After 100 days	After 120 days	After 140 days
	Grams	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Pollock	3,827	5.9	8.9	15.0	21.0				
Cod	2,674	7.4	11.0	18.2	25.5				
Sole	858	11.4	18.2	28.6	37.3	43.0			
Do	318	17.0	27.6	42.7	52.0	57.5	60.0	61.6	62.3
Haddock	570	9.6	16.6	28.1	37.2	44.8			
Do	179	15.1	26.2	43.3	54.2	62.0	65.0	66.5	66.5
Mackerel	421	3.3	7.8	14.9	19.9	24.2	27.1	29.4	31.1
Eel	349	8.3	12.3	17.7	20.9	22.6			

Table 12, from the same authors, shows the effect of boxing on reducing evaporation. Two haddock of about the same size were kept in storage, one hanging free and the other inclosed in a wooden box.

TABLE 12.—*Effect of boxing or loss of weight in storage*

Date	Weight		Date	Weight	
	Hanging free	Packed in a box		Hanging free	Packed in a box
	Grams	*Grams*		*Grams*	*Grams*
Aug. 13 (fresh)	449	473	Sept. 21	368	423
Aug. 14 (frozen)	477	452	Oct. 4	339	422
Sept. 1	411	430	Oct. 25	305	413

[27] See footnote 15, p. 518.

Table 13, also from Ehrenbaum and Plank, shows the amount of time found by them to be required for various fish to lose a very heavy glaze. The fish were suspended in the storeroom.

TABLE 13.—*Time required for ice glaze to evaporate from the surface of fish*

Species of fish	Weight of fish	Weight of glaze	Weight of glaze as percentage of weight of fish	Time that glaze lasted
	Grams	*Grams*	*Per cent*	*Days*
Mackerel	434	56	13.0	18
Do	365	56	15.3	18
Haddock	964	142	14.7	22
Do	428	50	11.7	14
Coalfish	4,270	472	11.1	33
Cod	2,588	252	9.8	28
Plaice	293	64	21.9	20
Do	184	46	25.0	15
Eel	296	41	13.8	14

These tables are all illustrative but do not represent conditions that prevail in American freezers. Our storage rooms are held at a very much lower temperature, the fish do not hang, and the glaze is not so heavy.

It is always the fish that are exposed on the outer parts of piles or cake that dry most. Those inside, especially in closely packed piles and boxes, dry least. Proximity to the cooling pipes hastens drying, and pipes freed from adhering snow cause much more rapid drying than those covered with snow.

When fish in storage are inspected the glaze is often found to have departed. When necessary the fish are glazed again. This may be accomplished in any of several ways depending on circumstances. The fish may be taken to the storage room and glazed in the usual way by immersing in water. If the fish are boxed considerable labor and damage to boxes is entailed by opening the boxes. In this event a portable tank is taken to the storage room and the boxes themselves are immersed in the tank and held under the water until they fill with water. They are then removed and suspended above the tank until the excess water drains out. To facilitate handling a davit is mounted on one end of the tank with block-and-fall and grapple hooks.

Fish piled loose may be reglazed conveniently by spraying them with water without moving them. A spraying tank and pump is used, such as horticulturists use for spraying shrubbery. The water freezes quickly on the fish. This is a quick, convenient, and satisfactory method.

REMOVING RUST

Where fish are rusty they may be freshened and improved by the following treatment: Two vats or tanks of tepid water (about 100° F.) are provided. Some sodium bicarbonate (ordinary baking soda) is dissolved in the water in the first tank, and two sticks are laid across the top. The cakes of fish, or large single fish, are laid on

these sticks. The water is taken up with stiff scrubbing brushes, narrow enough to reach into crevices, and the fish are scrubbed vigorously to remove the glaze. The fish are rinsed in the soda solution and then in the other tank of fresh tepid water. They are then placed in the sharp freezer for a short time to harden the surface and finally are glazed as usual and returned to the storage room.

TRANSPORTATION OF FROZEN FISH

RAILWAY TRANSPORTATION

In cool weather frozen fish may be transported in small lots in ordinary cars for short distances. For this purpose the boxes may be wrapped with several thicknesses of heavy wrapping paper, tacked

FIG. 20.—Delivery of frozen fish to trucks. Courtesy, Brooklyn Bridge Freezing & Cold Storage Co.

on. The shipment of frozen fish in warm cars is not very satisfactory, however, if the fish are to be kept frozen after arrival at their destination. For the great bulk of frozen fish shipped, refrigerator cars are used. These are railway freight cars with double wooden walls, with 1 to 4 inches of felt between the wood facings, which are lined with tar paper. There are cars with only 2 inches of air space or 1 or 2 inches of felt insulation in the walls, but these, and also cars with metal roofs and steel braces in the sides, which are heated in the sunshine, are less suitable for frozen fish. Refrigerator doors are provided with compression bolts for tight closure. In each end of the car is a space or "bunker" for ice, or ice and salt. Each bunker is provided with a hatch at the top for charging with ice, and drain-

pipes with traps at the bottom for discharge of brine. To allow circulation of cold air, there is an aperture about 1 foot wide at the top and bottom of the partition between the bunker and the body of the car. A heavy wire screen prevents the ice from falling through these openings. When the bunkers are charged with ice, or ice and salt, the cold air flows from the bunker to the car, through the lower opening, and is replaced with warm air from the car through the upper.

For dunnage the floor of the car is provided with heavy slat boards mounted on 2 by 4 timbers. These floor racks often are hinged down to prevent their removal from the car. Where "permanent" floor boards (slats nailed directly on the floor) are provided circulation is insufficient, and frozen fish may be partially defrosted.

Cars vary in all their dimensions. Table 14 shows the dimensions and capacities of several American and Canadian refrigerator cars. If the dimensions of these cars were standardized, it would be possible to standardize boxes for more economical packing, but as it is shippers must pack as best they can, often with much waste space. Pan-frozen fish usually occupy about 4 cubic feet per 100 pounds when boxed. The minimum car shipment is 24,000 pounds. In the larger cars as much as 33,000 to 35,000 pounds, or even more, can be packed.

TABLE 14.—*Inside dimensions of some refrigerator cars*

Railroad	Length		Width		Height		Capacity
	Feet	*Inches*	*Feet*	*Inches*	*Feet*	*Inches*	*Cubic feet*
Michigan Central	33	0	8	4	7	7	2,084
N. C. & St. L.	29	1	8	2	7	3	1,721
New York Central	39	11	8	5	7	6	2,518
Do	28	9	8	4	7	6	1,718
Canadian National	[1] 38	9¾	8	2	7	2½	2,713
Canadian Pacific	34	0	8	7	6	8	1,943
Soo Line	32	3	8	0	7	2	1,849
American Refrigerator Transit	33	4	8	4	7	7	2,105
Grand Trunk Pacific	33	2	8	1	6	5	1,719
Fruit Growers' Express	33	0	8	3	7	6	2,042

[1] Equipped for connection in passenger trains.

Usually the cars are refrigerated by packing the ice chambers with cracked ice and salt. The capacity of the bunkers is from 6,000 to 7,500 pounds of ice each, or 12,000 to 15,000 pounds for the car. Salt is mixed with the ice in the proportion of 10 to 15 pounds of salt to 100 pounds of ice, this figure being referred to as "percentage." Thus, 10 pounds of salt to 100 pounds of ice is referred to as "10 per cent" salt. (A true 10 per cent mixture would, of course, be 10 pounds of salt to 90 pounds of ice.) In winter the 10 per cent mixture is used. Some shippers increase the proportion to 12 per cent in spring and 15 per cent in summer. Other shippers use a 10 per cent mixture all year round. For oysters, which require a cool temperature above freezing, a 5 per cent mixture is used. Winter shipment, of course, is most satisfactory, as summer shipments, especially in the more southern latitudes and in warm periods, sometimes partially defrost and lose their glaze. The drainage valves remain open, so that the brine formed flows off.

Shucked oysters in cans and fresh fish in boxes often are stowed in the car and covered with cracked ice. The boxes of fish also contain ice with the fish.

PREPARATION OF CARS

In order to prevent the boxes of fish from coming in direct contact with the outside walls, where heat may be conducted directly to them, it is advisable to nail battens along the side walls. Two, or, better, three thicknesses of lath nailed on, vertically or inclined at a slight angle, with eight-penny nails, are sufficient. As an extra precaution the entire cargo is sometimes wrapped by laying building paper on the floor (if the floor battens are removable) and tacking it under the lath on the sides. The free ends are tacked temporarily to the ceiling while the car is being loaded. After the load is all in the ends of the paper are freed from the ceiling and brought around over the boxes, entirely surrounding the contents of the car.

PRECOOLING CARS

Best results are obtained if refrigerator cars are precooled before they are loaded. A common way to do this is to ice the bunkers 24 hours before the car is loaded. Some of the meat-packing houses bring the cars alongside the freezer platform and attach a large canvas duct or "tunnel" to the door leading from a cold room in the freezer. A large fan blows cold air into the car for a number of hours to precool the air and walls of the car. It is advisable to use a canvas cover over the passageway from freezer to car, in any event, to prevent the circulation of air during the loading.

Where quick precooling is necessary in an emergency, a 20 per cent ice and salt mixture is used in the bunkers during the loading. This strong mixture thaws more rapidly, reaches a lower temperature and chills the car more quickly. When the car is loaded, the bunkers are brought up to capacity with the 10 per cent mixture.

Where ice and salt are used in the bunkers it is unsafe, especially in warm weather, to pack the car entirely full of fish. Usually the car is packed to within 1 or 2 feet of the top. When the goods are all in, the boxes should be bracked tight to prevent shifting in transit.

It is highly important that the doors of the refrigerator cars should fit tightly so as to prevent the entrance of warm air into the car. The threshold should be cleaned carefully before the door is closed.

The cars are reiced in transit as required. This service is performed by the carriers at a comparatively low cost for ice and salt, usually plus a switching charge.

Refrigeration of cars with carbon-dioxide ice will be discussed in connection with the ice.

REFRIGERATOR-TRUCK TRANSPORTATION

In cool weather frozen fish may be transported for short distances in an ordinary open truck. Usually a tarpaulin is thrown over the load to cut off the direct sunshine. A closed van is preferable, how-

ever, where a longer haul is necessary, or in warm weather, refrigeration is required. For this purpose there are now in use truck bodies refrigerated by cold-brine circulation on the principle followed in the brine-refrigerated freight cars already described.

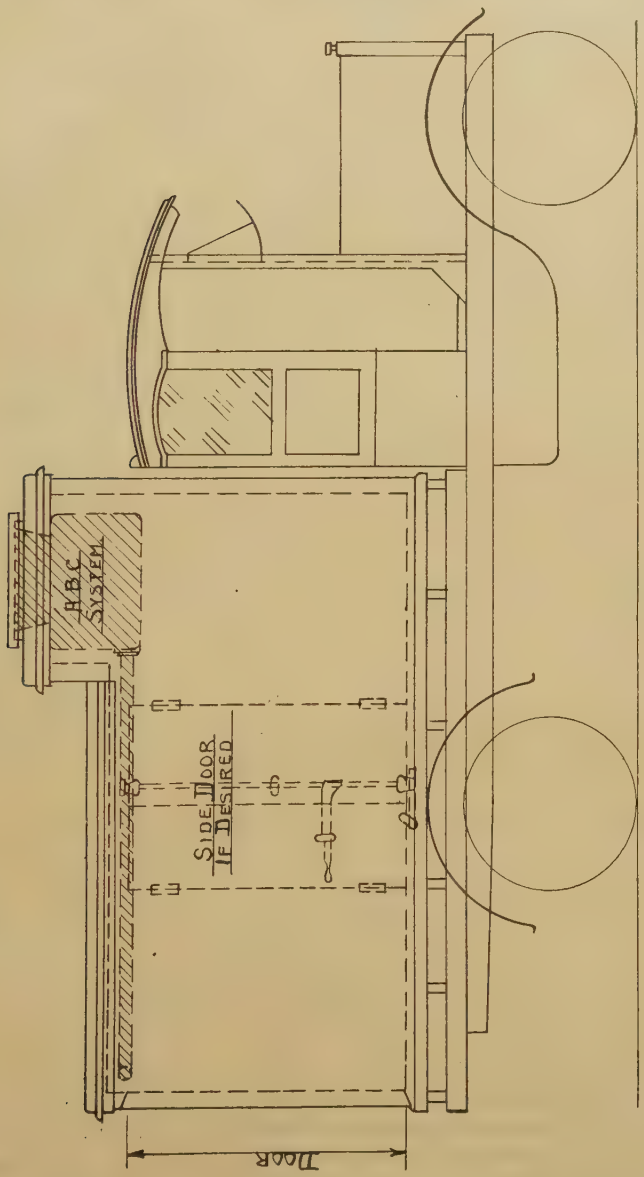

Fig. 21.—Construction of brine-refrigerated truck. Courtesy, Anheuser-Busch

There is a single bunker or tank at the top with brine pipes in the top of the freight body. An arrangement of valves causes the brine to circulate in the pipes when the truck is in motion. Ice and salt are put in the bunker in proportion to give the desired temperature

(which may approach zero if necessary). Such a truck is shown in Figure 21.

Dry ice or carbon-dioxide ice, next to be described, also may be used. A closed van should be loaded and from 100 to 200 pounds of crushed dry ice thrown over the boxes. A very rapid fall in temperature occurs, and the fish keep, frozen hard, for several hours in hot summer weather.

SOLID CARBON-DIOXIDE REFRIGERANT FOR TRANSPORTATION

As a means of refrigeration of cars for the transportation of fish, solid carbon dioxide has shown promise in trials. Although the application of this substance to the preservation and transportation of fish in commercial practice is still (August, 1926) too recent and experience is too limited to justify a prediction of its possibilities in the fish industry, yet it is being used for other products, and its possibilities for fish warrant a description of its properties.[28]

Carbon dioxide is familiar as the gas used in soda water. It is of widespread distribution, being present in small amount in air. It is produced by combustion of coal, wood, gas, etc., and may be recovered from flue gases. It is a noncombustible, nonpoisonous, invisible, heavy gas. When compressed to about 1,000 pounds per square inch it liquefies at about 80° F., and if the pressure is suddenly removed from the insulated liquid carbon dioxide some of it evaporates, and in doing so absorbs so much heat that the remainder freezes to a white, snowy substance having a temperature of about 109° F. below zero. This white "snow" is then compressed into bricks or other desired shapes. This compressed carbon-dioxide "ice," as its manufacturers have named it, weighs 70 pounds per cubic foot, as compared with 57 pounds per cubic foot of water ice. It contains about 1.7 times as much refrigeration per pound as water ice, or about 2.1 times as much per cubic foot. The amount of refrigeration available in this solid carbon dioxide, expressed in B. t. u. per pound of gas evaporation, and the gas warming to various temperatures is shown in Table 15.

TABLE 15.—*Refrigeration available in solid carbon dioxide*

Final temperature of gas, ° F.	Refrigeration available, in B. t. u.	Final temperature of gas, ° F.	Refrigeration available, in B. t. u.
−10	249	32	274
0	255	75	300
+20	267		

Eight cubic feet of the gas weigh 1 pound. The gas, at 32° F., has a specific heat of about 0.18. If this gas is at 109° below zero, F. as it comes from the ice, it absorbs only about 25 B. t. u. in being warmed to 32°. But this same gas, in passing from the solid to the gaseous state, absorbed 255 B. t. u. The refrigerating effect of the gas is therefore only about one-tenth of the ice from which it was produced.

[28] Elworthy, British patent 7436 (1895), U. S. patent 579866, Mar. 30, 1897; Slate, T. B., U. S. Patents 1511306, Oct. 14, 1924, 1546681, 1546682, July 21, 1925, 1563112, Nov. 24, 1925, and 1595426, Aug. 10, 1926.

The heat absorbed by the ice in its changing state must therefore reach the ice by direct conduction from objects in contact with it or by convection of the gas current. These facts have a significant bearing on the applications of this "ice" to refrigeration.

The term "dry ice" is used advisedly, for it does not melt to a liquid as water ice does, but, in absorbing heat, is converted directly into the gaseous state, the gas formed being also very cold until it, too, absorbs more heat. This gas is about one and one-half times as dense as air and consequently will sink to the bottom of an inclosed chamber, displacing the air. If sealed tight it will exert a powerful pressure, but if a means of escape is provided it passes out into the atmosphere.

Solid carbon-dioxide "ice," though very cold, may be insulated and transported for short distances, but with some loss, of course. It may be used for chilling a chamber, the temperature being regulated by insulating the solid to control the rate of evaporation. If blocks of it are placed in the upper part of a chamber they rapidly absorb heat and give off cold gas, which displaces the warm air, sinking to the bottom and gradually filling the entire chamber and surrounding contents. If much of the solid is used, with little or no insulation, the chamber may be chilled to an extremely low temperature; but if a small quantity is used, with heavy insulation, the chamber may be kept cool without freezing.

This gas has other useful properties. By displacing the air it arrests oxidation completely. This fact is probably of advantage in fat fish in preventing oxidation of fat (when air is present, oxidation actually produces heat). Many kinds of bacteria require oxygen, and when oxygen is displaced by carbon dioxide they either die or become inactive. By dissolving in the juice of the fish carbon dioxide produces a mild, harmless acid (carbonic acid), which also combats some bacteria. Carbon-dioxide ice is thus not only a refrigerant of valuable properties but its gas is an aid to preservation as well. It evaporates and disappears when the fish are taken out of it, leaving no taste or other objectionable trace.

USE OF CARBON DIOXIDE ICE IN THE SHIPMENT OF FISH

The pioneers in the manufacture and application of solid carbon dioxide to refrigeration and preservation of food[29] arranged, at the request of the Canadian Department of Marine and Fisheries, to send a trial car of fish from Halifax to Montreal, the distribution of the fish to the trade being arranged by the Canadian Fisheries Association.[30] A refrigerator car was equipped at the four corners (outside the ice bunkers) with cylindrical metal containers 12 inches in diameter and 70 inches high, in which cylinders of solid carbon dioxide were placed, the entire charge weighing 850 pounds.

The car was packed at Halifax with an assortment of frozen fish and fish on ice and sent to Montreal, being four days en route, and allowed to stand on the tracks two days—six days from the time of sealing. When the car was opened the air (or gas) temperature was 33° and all the fish were in excellent condition.

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[29] The Dry-Ice Corporation of America, 50 East Forty-second Street, New York City.

[30] For full report on this shipment, see reports in Canadian Fisherman, Vol. XI, May, 1924, pp. 111–120. Gardenvale, Province of Quebec. There are numerous technical errors in the report.

Following upon the favorable results of tests in its research laboratory, the Atlantic Coast Fisheries Co. made several shipments, under the immediate supervision of the writer, of packages of frozen fillets of fish from New York to Kingston, Jamaica, on ships without re-

FIG. 22.—Solid carbon dioxide or dry ice being loaded on a truck. Courtesy, Dry Ice Corporation of America

frigeration. The frozen blocks of fillets, with dry ice between, were packed in corrugated strawboard boxes for insulation. The shipments arrived in seven days, all in perfect condition. In April, 1926, following the above preliminary shipments, the first car of frozen fish was shipped from New York to Detroit—a three-day trip.

Twelve hundred pounds of dry ice was used, contained in wooden fish boxes and distributed in the upper layer of boxes of fish. Bunker openings were sealed with building paper nailed on with lath, likewise the doors. The car arrived in good condition. Two more cars followed in June and July, 1926. Numerous shipments then were undertaken from Provincetown, Mass., to St. Louis and Kansas City and from New York to the same points in the hottest summer weather, the time of transit being five to six days. These cars arrived in excellent condition, except when insufficiently insulated cars were used. Recording thermometers in two of the cars showed virtually constant temperature of 26° to 28° F. throughout the trips.

In the three-day shipments 1,200 pounds of boxed ice were included and 200 pounds of granulated ice were scattered over the load just before the car was sealed to effect rapid cooling of the car. In the five and six day shipments 1,500 pounds boxed and 200 pounds granulated were used at first. All the ice was gone on the arrival of the cars, which were tight and well insulated, but the fish were frozen hard. In the later cars of five and six days the amount was increased to 1,800 pounds boxed and 200 pounds granulated, and at the end of five days about 200 pounds remained in the boxes. In other cases 2,400 pounds, all in boxes, were used. Where 1,800 pounds were used, the ice was contained in 10 boxes of 180 pounds each. In some of the cars rather serious defrosting had occurred; in others the fish were held perfectly. In the unsatisfactory instances the trouble apparently was caused by insufficient insulation and leaky doors and bunkers.[31]

In the shipments from Provincetown the ice was shipped by express in boxes of sawdust.

Practical experience in these shipments has yielded information that may be summarized as follows:

It is practical to ship frozen fish in the hottest summer weather, up to six days on the road, as the fish remain frozen by the use of dry ice alone.

A tight car with heavy insulation should be ordered without precooling. Movable floor racks, 4 inches deep, should be on the floor. The bunker openings into the car should be sealed with building paper and lath. Strips of 1-inch wood (or three thicknesses of lath) should be nailed vertically on the sides of the car to prevent any possibility of the boxes coming in direct contact with the walls. The door not used for loading should be similarly sealed inside. The car should be filled as full as possible—up to within 2 to 4 inches of the ceiling—with frozen fish, in boxes, as a full car is more favorable to refrigeration with dry ice than a part car. Dry ice, in 8 to 10 wooden boxes, should be distributed in the top layer so as (1) to come next the ends and sides of the car, (2) not to come next to one another, and (3) to be uniformly distributed over the load. There should be no sawdust or insulation around the dry ice, but the boxes may to advantage be lined with heavy paper.

The dry ice should be delivered to the car with the fish, and loading should be prompt. When the load is in, or during loading,

[31] Solid Carbon Dioxide, or Dry Ice, in the Fish Industry. By Harden F. Taylor. Ice and Refrigeration, vol. 71, 1926, pp. 211–213. Chicago.

200 pounds of crushed dry ice should be thrown over the top of the load. (Handle quickly with a shovel or dry cotton gloves.) The door should be sealed with a strip of putty or a rubber tube against all facings. The bunker hatches and the brine vents in the bunkers should be closed tight. Do not open the car, once it is closed, until it reaches destination.

One of the reasons for preferring a well-filled car of fish when dry ice is used is, for one thing, that it reduces cost, for no more dry ice is needed for a full car than one-half full, whereas with ordinary ice it is usually unsafe to pack the car entirely full. Another reason, however, is not so obvious. A pound of dry ice produces 8 cubic feet of gas. In an empty car of, say, 2,000 cubic feet capacity, 2,000

FIG. 23.—Frozen steelhead in refrigerated hold of a steamer from Pacific coast ports to New York, via Panama Canal. For transoceanic shipments the boxes must be strapped

pounds of dry ice will fill the car eight times with gas; that is, the gas will be changed eight times as the ice evaporates. If half the space is occupied with fish, the gas will be completely changed 16 times; if the car is seven-eighths occupied by fish, the cold gas will be changed 64 times, insuring a cold atmosphere in the car at all times.

Carbon dioxide ice may also have possibilities in the refrigeration of individual packages of fresh or frozen fish, oysters, and other perishable sea foods. Its dryness and cleanness are desirable properties for this purpose and make possible the use of paper or fiber containers for express or even parcel post. At the present writing, however, though numerous trial shipments have been made, one is unable to speak with confidence as to its ultimate usefulness in this field.

OCEAN TRANSPORTATION

Refrigerator ships provide facilities for storage aboard similar to those in cold-storage warehouses, with those differences that are made necessary by the construction and operation of the ship. The holds are insulated with cork, with pipes overhead and on the walls. Battens usually are provided on the floors. The temperature commonly maintained ranges from 18° to 20°, which is high for long storage but answers the purpose for the short time of a voyage. The machinery is either the carbon dioxide or ammonia compression type. Ships usually have one or two spare machines, complete, and a full supply of spare parts to be used in case of a breakdown, which would be diastrous if spare parts were not available.[32]

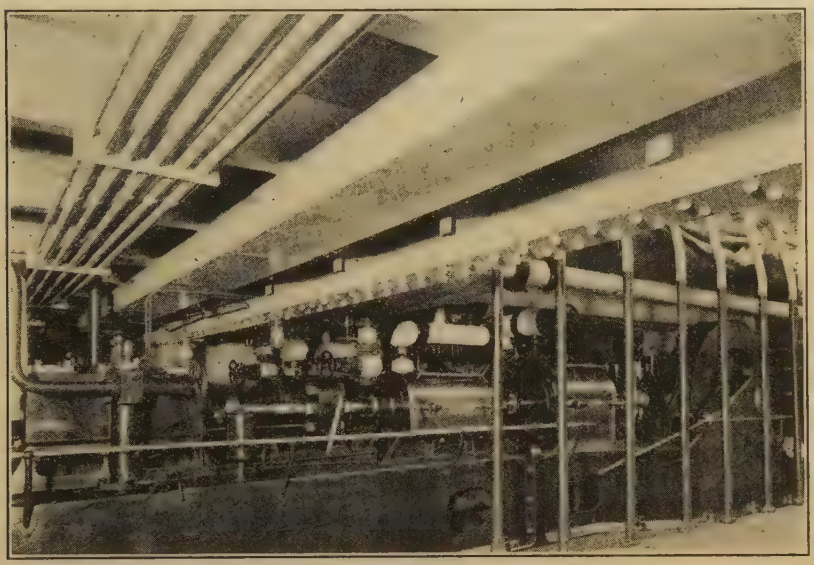

FIG. 24.—Carbon dioxide refrigeration machinery aboard a steamship

Boxes for ocean transportation should be strong, well nailed together, and are required to be strapped or wired. Transportation from freezer to ship is usually effected by trucks. This practice affords some opportunity for the fish to receive some heat, especially if there is any delay in transferring them to the refrigerator hold of the ship. When there is a railroad track alongside the freezer, connecting with a track on the wharf, it is excellent practice to pack the fish in a refrigerator railroad car, with bunkers iced, and have the car shifted to the wharf. In handling large lots this is cheaper than transfer by truck.

[32] For discussion of practical details see "The design and construction of refrigerated ships," by Llewellyn Williams. Paper read at thirty-second general meeting of the Society of Naval Architects and Marine Engineers, New York City, Nov. 13 and 14, 1924. Also, "Ship's refrigeration," by Robert F. Massa. Cold Storage and Produce Review, vol. 20, No. 227, February, 1917, p. 40; No. 228, March, 1917, pp. 62-64; No. 230, May, 1917, p. 104.

OTHER METHODS OF FREEZING

The method already described in detail has come into widespread use because it is simple, practical, and is equally applicable to all varieties of fish. The chief and only serious objection to it is the slow rate of freezing. In connection with the discussion of the operation of sharp freezers numerous suggestions were made, intended mainly to increase the rate of freezing, and if these were all applied general improvement would result. But after everything possible is done, sharp freezers are still far too slow to produce all that could be desired because of the insurmountable difficulty of an exceedingly poor heat conductivity and the low specific heat of air.

In a sharp freezer most of the heat from the fish is absorbed by air surrounding the fish, and the air in turn gives up its heat to the pipes. The heat must pass from fish to air and from air to pipes—it must be conducted. Of all substances, air is one of the poorest conductors of heat known. Expressed in the metric system, its conductivity, as compared with that of some other substances, is shown in Table 16.

TABLE 16.—*Heat conductivity of various substances*

Substance	Conductivity, in calories per ° C. per second	Substance	Conductivity, in calories per ° C. per second
Air at 0° C	0.0000568	Mercury	0.01479
Water at 4.1° C	.00143	Iron	.152
Ice	.00568	Copper	1.079

The specific heat of air likewise is exceedingly small; that is, a relatively small quantity of heat causes a relatively large rise in the temperature of air. The specific heat of a substance is defined as the number of heat units required to raise a unit weight of that substance 1°. The specific heat of water is the standard, its specific heat being taken as unity. The specific heat of air, as compared with that of some other substances, is shown in Table 17.

TABLE 17.—*Specific heat of various substances*

Substance	Specific heat	Substance	Specific heat
Air	0.24	Brine, salt, 100 per cent saturation	0.783
Water	1.00	Sea water	.94
Brine, salt, 80 per cent saturation	.829	Ice	.50

The above figures are on the basis of weight and heat units, say, pounds and British thermal units. That is, 0.24 B. t. u. would be required to raise the temperature of a pound of air 1° F., while 1 B. t. u., or four times as much heat, would be required to raise the temperature of a pound of water 1°. But a pound of air occupies 11 cubic feet while a pound of water is approximately a pint. Only a very small weight of air is actually in contact with the fish at one

time—perhaps not more than a few thousandths or ten-thousandths of a pound—and this of only one-fourth of the heat capacity of water. The temperature of air rises markedly when the fish has given up only a very small quantity of heat. When its temperature rises, the rate of flow of heat is reduced, the rate of flow being proportional to difference in temperature. The heat given off by a 1-pound fish in freezing will raise the temperature of 310 cubic feet of air 10° F.

If the air in a freezing room should remain still, the fish might require weeks to freeze; it is only the circulation of air that makes ordinary sharp freezers practicable. Air in immediate contact with solid objects, however, moves very sluggishly, a sort of static film being formed. Blowing the air by a fan greatly increases the speed of freezing, as has been shown elsewhere; but this principle seems impracticable of application in freezing large quantities of fish because of the immense volume of air that would have to be moved.

It becomes evident, therefore, that if very much more rapid freezing is to be accomplished recourse must be had to a medium of higher conductivity and specific heat than air or any other gas. Any liquid is vastly better than any gas, hence the use of brine. The greater rapidity of freezing of fish in brine than in air is shown by the experimental results given by Stiles [33] in Table 18.

TABLE 18.—*Time required to freeze fish of various thicknesses in air at 14° F. and in solutions at 14° and 6° F. below zero*

Thickness of fish in—		Time required to freeze in—		
		Air at 14° F.	Brine at 14° F.	Brine at 6° F. below zero
Centimeters	*Inches*	*Minutes*	*Minutes*	*Minutes*
1	0.39	120	10	4
2	.79	248	21	8
3	1.18	361	35	14
4	1.57	490	54	19
5	1.97	620	78	29
6	2.36	748	112	40
7	2.75	877	148	50
8	3.15	1,000	190	67
9	3.54	1,130	230	85
10	3.94	1,260	275	101

These figures are illustrative only. In this country air temperatures much lower than 14° F. below zero are used regularly, and the brine temperature of 4° F. below zero is much more advisable and more likely to be used than 14° F. above, as in the table.

At this point it will be well to remember that the object of achieving more rapid freezing is solely to improve the quality of the frozen fish and not to increase the output of a freezer. In every case the amount of fish that can be frozen per day is limited by the capacity of the ammonia machine. Brine freezing will greatly increase the speed of freezing of any one fish, while other fish, unfrozen, await their turn. In sharp freezers all the fish are put

[33] See footnote 47, p. 583.

in at about the same time, while in brine the fish pass through the process in small lots; but, other things being equal, as much time would be required to freeze a day's capacity by one process as by another.

The means of freezing fish may be classified for the purposes of this discussion as (*a*) those methods in which fish are immersed directly in or exposed directly to brine, and (*b*) those methods in which fish are inclosed in molds, cells, or containers, the walls of which separate the fish from the brine but make good contact with both. These two classes of freezing methods will now be discussed at some length.

FREEZING IN CONTACT WITH BRINE

If the liquid to be used for freezing is to come in direct contact with the fish, we are limited virtually to sodium chloride or common salt brine. It is the only chemical substance that is tolerated by the human palate and stomach, while being cheap, harmless, and affording a solution of sufficiently low freezing point. Calcium-chloride brine has an acrid, disagreeable taste, and any trace left on the fish would be objectionable. The same may be said of magnesium chloride. Glycerin and alcohol are excessively expensive and are otherwise objectionable. A mixture of salt brine and glycerin has been proposed and is being used to some extent.

STERILIZING EFFECT OF BRINE.

Strong brine has a distinctively destructive effect on bacteria, as is well known from its use as a preservative for meat, fish, etc. Coming in direct contact with the slime on the skin and gills of fish, where decomposition starts very easily, the strong brine used in freezing plasmolyzes and kills many putrefactive bacteria. Green has investigated, bacteriologically, the keeping quality of brine-frozen fish in comparison with those frozen in air. Her report on this work is as follows:

> Samples of brine and dry frozen fish were brought out of store and placed on trays with an equal number of perfectly fresh herrings straight from the drifter. These were left away from the sun and wind at a temperature of about 60° F. for two or three days, and then bacteriological samples were taken from them and inoculated into fish broth.
>
> *Observations.*—(*a*) Brine-frozen herrings produced the least amount of bacterial growth. (*b*) Dry-frozen herrings produced by far the greatest amount of growth. This experiment, like the first, shows that bacteria do continue to multiply at a temperature of 18 to 20° F., whereas the brine-freezing method not only inhibits growth but kills many of the forms of bacteria present before they have time to spore.

RAPIDITY OF FREEZING IN BRINE

Figures that show the speed of freezing in brine as compared with that in air already have been given (p. 571). The larger the fish to be frozen, the smaller the difference, as shown in Table 17. It is easily understood why the larger objects freeze more slowly than the smaller ones, when we remember that the volume of a solid object increases as the cube of its diameter, while its surface increases only

as the square of the diameter. Thus, a ball 4 inches in diameter has four times the surface and eight times the volume of a 2-inch ball; or, that is, the 2-inch ball has twice as much surface in proportion to its volume as the 4-inch ball has. Likewise, a fish 1 foot long has twice as much surface in proportion to volume as a 2-foot fish of the same kind.

The amount of heat in a fish is proportional to its volume; but as the fish freezes the heat must pass through the surface, and this surface is proportionately smaller the larger the fish. In the table it is apparent that a fish twice as thick as another freezes only about half as fast in air; but the same ratio is not apparent when the freezing is done in brine, where doubling the thickness approximately triples the time required to freeze. The reason for this is that in air freezing, which is very slow, the heat has time to be conducted from the inner parts of the fish to the surface, and the amount of surface exposed will determine how long it takes the fish to freeze. But in brine the surface very quickly reaches the temperature of the brine, and the heat must then be conducted from some distance through a shell of frozen tissues; the area of surface thus has relatively less to do with the rate of freezing in brine, and the heat conductivity relatively more, than in air. Thus, a fish 2 inches thick will freeze in brine about 13 times as fast as it will in air, while a 4-inch fish will freeze only about 8.8 times as fast. A fish 10 inches thick would freeze only about 4.5 times faster in brine than it would in air, the air and brine being, of course, at the same temperature. These same remarks apply to the packing of small fish in pans or molds. This practice has the effect of making a larger fish of several small ones, reducing the surface exposed and lowering the rate of freezing.

The rate of movement of the brine is also highly important in determining the rate of freezing in brine, as illustrated in Table 19, taken from the work of Dunkerley.[34] As will be seen later, this fact is of the greatest importance in the design and operation of brine freezers.

TABLE 19.—*Time required to freeze fish in brine.* (*From Dunkerley.*)

Thickness of fish in inches	Still brine at 10° F.		Brine at 10° F. moving 3 feet per second		Thickness of fish in inches	Still brine at 10° F.		Brine at 10° F. moving 3 feet per second	
	Hours	*Minutes*	*Hours*	*Minutes*		*Hours*	*Minutes*	*Hours*	*Minutes*
1	0	25	0	14	4	4	10	3	0
1½	0	45	0	26	4½	5	0	3	45
2	1	20	0	50	5	6	0	4	37
2½	1	50	1	15	5½	7	0	5	30
3	2	35	1	45	6	8	15	6	30
3½	3	15	2	18					

Dunkerley also gives the following formula for calculating the time required to freeze fish at any temperature if the time required to freeze in brine at 10° F. is known. His formula is:

$$\text{Time} = \frac{(\text{Time at } 10^\circ \text{ F.}) \times 20}{30 - (\text{Brine at desired temperature})}$$

[34] "Fish freezing in brine," by H. M. Dunkerley. Fish Trades Gazette and Poultry, Game, and Rabbit Trades Chronicle, Mar. 30, 1918, p. 19. London.

Thus, a fish will freeze 20 per cent faster in brine at 5° F. than it will in brine at 10° F. He found that a fish is frozen solid when the temperature at the backbone is 25° F.

EARLIER METHOD OF BRINE FREEZING

It so happens that both freezing in brine and in freezing molds surrounded by brine originated with the same inventors. Hesketh and Marcet,[35] in 1889, patented the principle of immersing perishable articles directly in cold brine, with or without protective covering or container, or else inclosing the goods in water-tight cells with hollow walls in which brine is circulated. Nothing came of the invention. In 1898 Henry Rouart[36] obtained a patent covering very nearly the same ground. Rouart employed a tank of brine with cooling coils (in the bottom) and agitator to move the brine.

In 1899 H. W. Rappleye, of Philadelphia, patented[37] what appears again to be essentially the same thing as covered by Rouart and

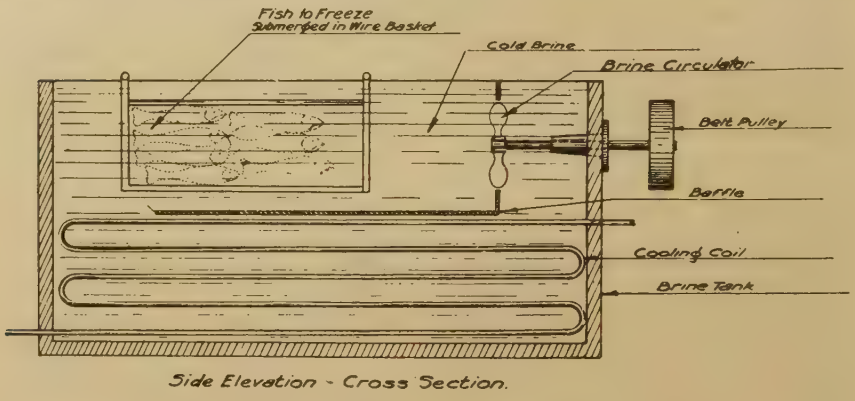

FIG. 25.—Apparatus similar to Rouart's, used for freezing smelts at Seattle, Wash. Courtesy, Booth Fisheries Co.

more broadly by Hesketh and Marcet; namely, immersing the perishables to be frozen directly in a tank of brine refrigerated with an ammonia machine.

KYLE'S METHOD

In 1905 T. D. Kyle[38] devised a method of chilling and freezing fish by placing them in a tank of refrigerated sea water, which was filtered through charcoal and a sponge filter. When the fish had been cooled in this tank they were gutted and transferred to another tank of concentrated sea water for further refrigeration. Here they could be kept a time for sale or they might then be sorted, packed in pans, covered with pure filtered sea water, and frozen to a block. The same ground was again covered by J. R. Henderson[39] in 1910 and 1913,

[35] British Patent 6117, Apr. 9, 1889.
[36] British Patent 5378, Apr. 16, 1898.
[37] U. S. Patent 626771, June 13, 1899.
[38] British Patent 16916, 1905.
[39] British Patent 30221, Dec. 29, 1910; U. S. Patent 1055636, Mar. 11, 1913.

who also precooled the fish either in a cool room or in cool brine containing about 6 per cent salt held at 27° to 30°, after which precooling they were frozen in a tank of saturated brine at a low temperature—about 5° F. above zero. The brine was refrigerated by a cooler outside the freezing tank. Henderson also used a charcoal filter for purifying the brine after it had been in use.

All these inventions, appearing to be essentially the same thing, failed to come to practical application, and all the patents have expired except that of Henderson. It is not difficult to understand why these inventions failed. It is easy to demonstrate the freezing of a few fish quickly in a tank of very cold brine, the quantity of which is large in proportion to the amount of fish to be frozen, and the quality of the goods frozen in such a demonstration is easily

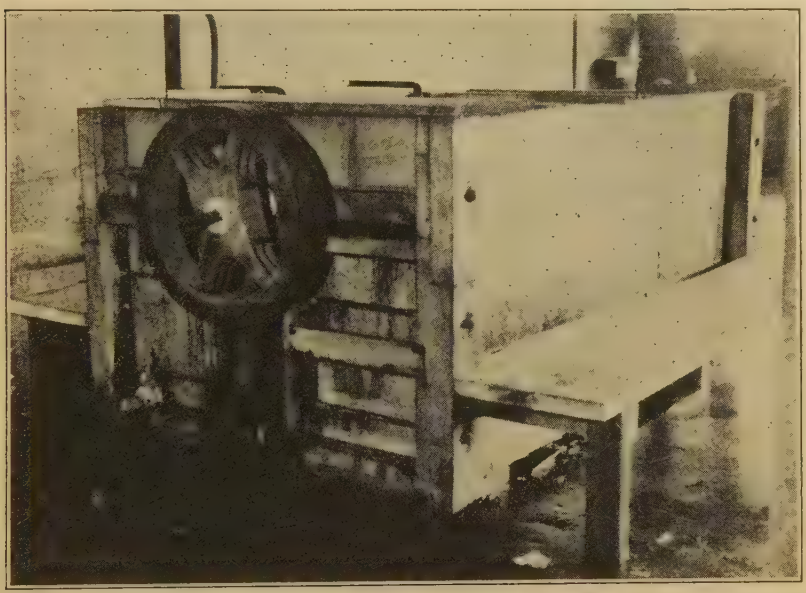

FIG. 26.—Brine freezer similar in principle to Rouart's, used for freezing smelt at Seattle, Wash.

apparent. It is by no means so easy, however, to freeze 25,000 to 100,000 pounds of fish a day, wash them, glaze, pack, and store when open tanks of brine are used, the fish being frozen singly, wet with brine, curled, and misshapen.

DAHL'S METHOD

The first brine-freezing method to be put into practice was that of Nekolai Dahl,[40] a fish merchant of Trondhjem, Norway.

The fish are packed in the containers in which they are to be shipped. A cover, with holes, is fitted on the box, and the boxes are stacked on a mass of cracked ice and salt in a chamber or hold of a vessel. A suction pipe is provided in the bottom of the cham-

[40] U. S. Patent 1123701, Jan. 5, 1915; Danish Patent 18844, 1914; British Patent 13760, Mar. 6, 1912.

ber, connected with a brine pump. The pump draws up the brine formed by the ice and salt mixture and forces it into pipes, which distribute the brine as a spray over the boxes of fish. The cold

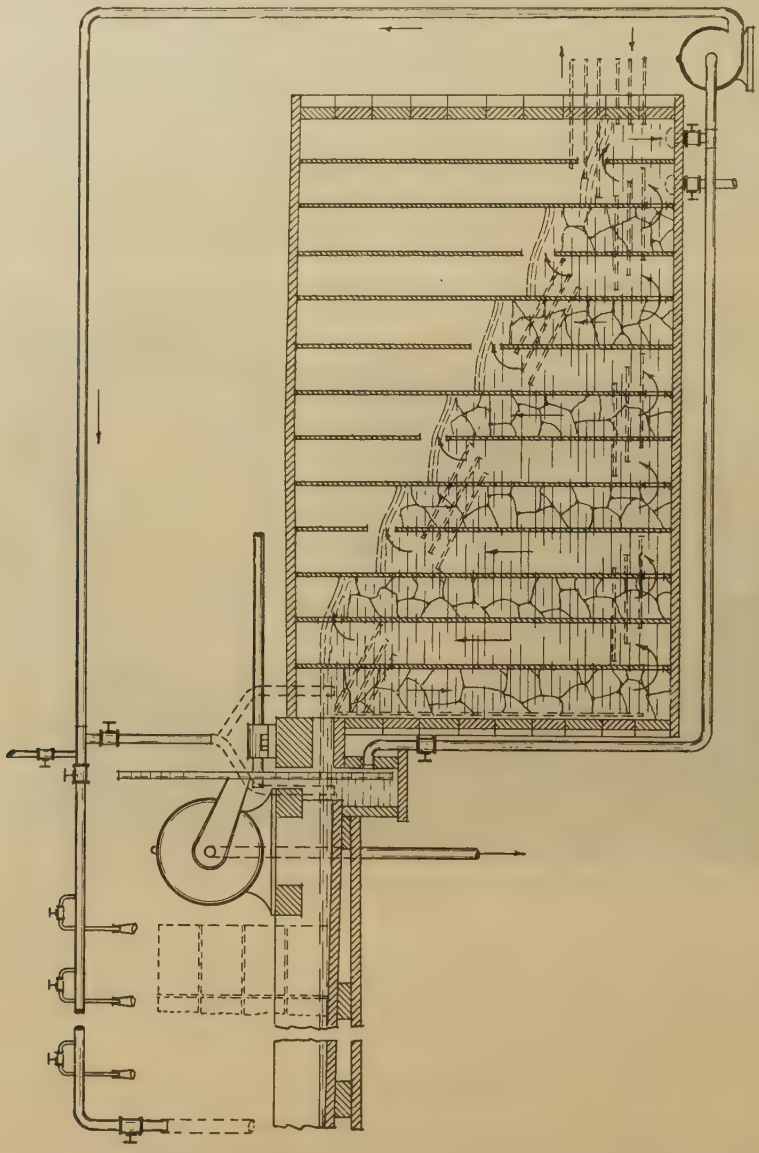

FIG. 27.—Dahl's method of forming brine for freezing fish

brine trickles down into the boxes, through the holes and apertures in the lids, and coming in contact with the fish, freezes them.

An improvement [41] on the original consisted in a tank divided into chambers, wherein the ice and salt mixture was placed. The brine formed passed through the pump without entraining the cracked ice.

[41] U. S. Patent 1177308, Mar. 28, 1916; British Patent 6711, Mar. 17, 1914.

(See fig. 27.) This brine was pumped over the boxes of fish as in the original invention.

In a later improvement Dahl[42] stood the cases on end and bored a hole in each end. The fish in the cases then standing parallel with the downward flow of brine afford a better flow and are more thoroughly exposed to the refrigerating action of the brine.

Dahl patented another improvement[43] by way of effecting a better distribution of brine among and contact with the fish. He first

FIG. 28.—Small plant for freezing by Dahl method. The fish are put in the boxes and brine pumped in through the hose

inserted a brine-discharge hose among the fish, for a short time, to stiffen them, after which operation they remain better separated during the subsequent freezing by the brine flowing among them.

The fish frozen by Dahl's process are not glazed and appear to be more suitable for shipment and consumption after a short time than they are for prolonged storage. Installations of apparatus for freezing on the Dahl principle have been made at Los Angeles, San Diego, and San Francisco, Calif. These consist of the brine-forming com-

[42] U. S. Patent 1235661, Aug. 7, 1917; British Patent 109238, Sept. 6, 1917.
[43] U. S. Patent 1367024, Feb. 1, 1921.

partments and several compartments for fish, wherein the brine is pumped through flexible nose.

A small plant, built after the Dahl design, for freezing with ice and salt brine, was built in Fernandina, Fla., for freezing shrimp. The ice and salt were put in chambers, and the brine formed was circulated by a centrifugal pump through the freezing chamber. Shrimp were dumped directly into the brine. They froze in a few minutes. They were left in it about three minutes, taken out, drained a few minutes on the floor, boxed, and stored at about 0° F. At first these shrimp appeared to be of excellent quality, but after a few months' storage they developed a bad appearance. The delicate pink changed to a less pleasing orange color, blackish in places, and the meat darkened. On microscopic examination the otherwise beautiful tentacled pigment cells were found to have disintegrated. Direct freezing in brine appears to be unsuited to shrimp. This criticism is, of course, no more applicable to Dahl's method of freezing than to others wherein brine comes into direct contact with the shrimp.

OTTESEN'S METHOD

A. J. A. Ottesen,[44] of Thisted, Denmark, patented in several countries a principle that has to do with the relation of the temperature and concentration of brine to the penetration of salt into the fish. As the question of salt penetration is an important one for all methods of freezing where the fish come into direct contact with brine, space will be taken here to discuss this subject at some length.

PENETRATION OF SALT INTO FISH IN BRINE FREEZING

It is a well-known fact, of course, that fish or other flesh substances when treated with salt absorb some of the salt that diffuses throughout the tissues. Likewise, some of the water in the tissues passes out and dissolves the salt, to form brine. When strong brine is used instead of dry salt, the same exchange occurs in a somewhat diminished amount—salt penetrates the fish and water comes out and dilutes the brine. This exchange of water and dissolved substance is called osmosis. Osmosis always occurs whenever a permeable membrane (in this case the cell membranes) separates a strong solution of a crystallizable substance from water or a weaker solution (in this case the fish juice). Osmotic pressure (the tendency to osmose) diminishes with diminishing temperature.

Salt penetration is a much slower process than the freezing of fish in brine. A fish that under the most favorable conditions would salt through in 24 hours will freeze in brine in one-half an hour. Nevertheless, even a small amount of penetration is objectionable. It interferes with glazing; for just as salt dissolved in water lowers its freezing point just so does it lower the freezing point of the surface tissues of the fish and prevents a glaze from sticking. Also, if salt is present in any considerable proportion the flavor will be

[44] U. S. Patent 1129716, Feb. 23, 1915; British Patent 24244, Sept. 4, 1913; French Patent 449815, Jan. 4, 1913. Patents were also issued to him in most of the other important fishing countries of the world.

affected. This was a difficulty, perhaps a fatal one, in the earlier attempts at brine freezing made by Hesketh and Marcet, Rouart, Rappleye, and Henderson. Ottesen discovered that if the proper relations of concentration and temperature are observed penetration of salt may be reduced to a minimum, so much that it ceases to be objectionable.

Warm water will dissolve more salt than cold water. If we saturate some warm water with salt and then cool the brine, some salt will precipitate out as small crystals, leaving the brine weaker. If we cool it more, some more salt crystallizes out and the brine is still weaker. We can continue to cool it with separation of salt until we get a temperature of 6.16° F. below zero, when the brine will freeze solid. At this temperature the liquid portion contains

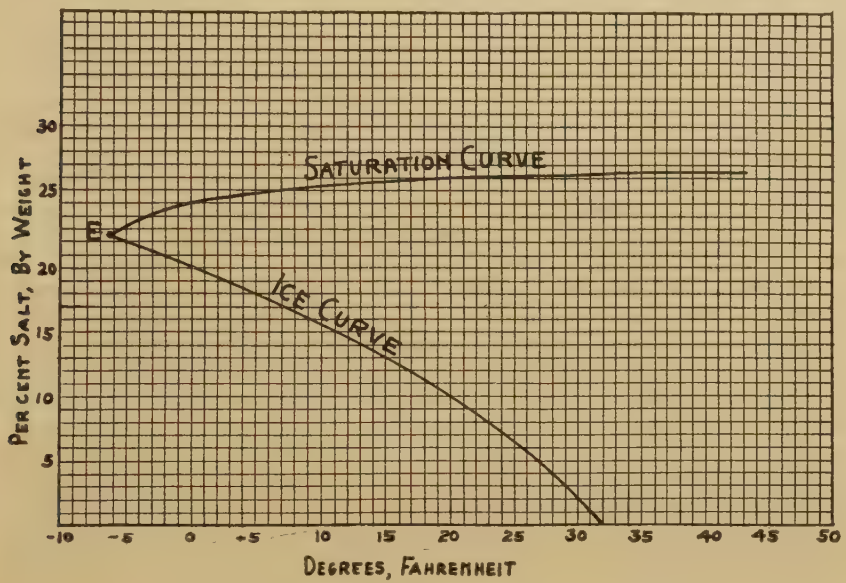

FIG. 29.—Temperature saturation curve of salt brine

22.42 per cent salt. If we begin with a brine of such strength that it is completely saturated with salt and immerse fish in it there will be penetration. The upper part of the curve in Figure 29 represents the concentration of the liquid portion, corresponding to the temperatures.

Now, if we begin with a very dilute solution of salt and cool it. what happens? The temperature drops slightly below 32° F., with no apparent change, because the salt has lowered the freezing point of the water. A degree or two below 32° crystals appear, but they are water ice and not salt. The separation of water in the form of ice leaves the brine more concentrated, and its freezing point falls. As we continue to extract heat more water separates out as ice and the remaining brine becomes stronger and stronger, as indicated by the lower part of the curve in Figure 29. When a temperature of

6.16° below zero is reached, enough water in the form of ice has been removed from the brine to leave the liquid portion at a concentration of 22.42 per cent salt. This is the same figure we arrived at when we began with the strong brine. That is to say, at a concentration of 22.42 per cent salt and 77.58 per cent water, by weight, and a temperature of 6.16° F. below zero, both ice and salt will separate together or the brine freezes as a mass. This concentration and temperature point is called the cryohydric or eutectic point, shown in Figure 30 where the two curves meet. It is the lowest temperature that can be had with liquid salt brine, whatever the initial concentration may have been. It is useless, therefore, to start with more than 22.42 per cent salt or a specific gravity of brine of 1.171 (about 84.64 per cent saturation at 60° F.)

Suppose the brine to be of a lower concentration, however, say, 20 per cent. The freezing point of such a brine is 0.14° F. above zero. It can be cooled to any temperature above this point without separation of either ice or salt. Ottesen discovered that if brine is less than saturated (that is, less than 22.42 per cent salt) and is cooled until water begins to separate, penetration of salt into the fish immersed in it is at a minimum as long as ice is separating, or as long as the conditions represented are on the lower ice curve in Figure 29. He reasoned thus: If water separates from the brine as ice at this temperature, certainly water can have no tendency to mix with it. A drop of water added to such a brine will not mix with it but will freeze as a pellet of fresh ice or a cluster of ice crystals. Therefore, the water on and in the fish will not combine with the brine or absorb salt, but will freeze without mixing with the brine. If, however, the quantity of warm fish is sufficiently great to warm the brine and thaw out all the separated water ice, penetration will take place. Hence the necessity for having an excess of free ice in the brine when freezing begins. He therefore claims that when the unsaturated brine is at its freezing point [45] and an excess of fresh-water ice is present the surface moisture and skin of the fish freeze immediately and thenceforth form an effective barrier against the further penetration of salt. Table 20 gives the cryoscopic properties of salt brine.

[45] "Freezing point," to fit the use Ottesen makes of it, must be defined as the temperature at which water ice begins to separate from a brine of less than 22.42 per cent salt. An important distinction must be made between the use of the term "freezing point" for brine and for water, which has a true freezing point at 32° F. In this sense, only brine of 22.42 per cent salt has a true freezing point—6.16° F. below zero—at which temperature it will freeze solid without change of temperature.

TABLE 20

Specific gravity 60°/60° F.[1]	Degrees Baumé 60° F.	Degrees salometer 60° F.	Per cent salt by weight	Pounds salt per gallon solution	Freezing point °F.[2]	Changes in brine before solidification
1.00000	0	0	0	0	32.0	Ice separates.
1.00725	1.04	3.8	1	0.084	31.1	Do.
1.01450	2.07	7.6	2	0.169	30.0	Do.
1.02174	3.08	11.4	3	0.256	28.9	Do.
1.02899	4.08	15.2	4	0.344	27.9	Do.
1.03624	5.07	18.9	5	0.433	26.8	Do.
1.04366	6.07	22.7	6	0.523	25.5	Do.
1.05108	7.06	26.5	7	0.617	24.1	Do.
1.05851	8.01	30.3	8	0.708	22.9	Do.
1.06593	8.97	33.9	9	0.802	21.2	Do.
1.07335	9.90	37.5	10	0.897	19.8	Do.
1.08097	10.86	41.3	11	0.994	18.2	Do.
1.08859	11.80	45.2	12	1.092	16.5	Do.
1.09622	12.73	49.2	13	1.190	14.7	Do.
1.10384	13.64	53.0	14	1.289	13.1	Do.
1.11146	14.54	56.8	15	1.389	11.3	Do.
1.11938	15.46	60.6	16	1.493	9.1	Do.
1.12730	16.37	64.4	17	1.602	7.2	Do.
1.13523	17.27	68.2	18	1.710	4.8	Do.
1.14315	18.16	71.9	19	1.819	2.5	Do.
1.15107	19.03	75.5	20	1.928	−0.1	Do.
1.15931	19.92	79.1	21	2.037	−2.2	Do
1.16755	20.80	83.0	22	2.147	−5.3	Do.
1.17101	21.15	84.6	22.42	2.197	−6.16	Freezes solid.
1.17580	21.68	86.9	23	2.266	−5.3	Salt separates.
1.18404	22.54	90.9	24	2.376	−3.3	Do.
1.19228	23.39	94.7	25	2.488	+7.0	Do.
1.20098	24.27	98.5	26	2.610	21.5	Do.
1.20433	24.60	100.0	26.395	2.661	59.0	Do.

[1] Temperature correction 1° salometer for every 7½° F. added to reading for temperatures above 60° F., subtracted below. There is also a salometer scale in use with 1° equal to ¼ per cent salt 0=1.0000 sp. gr. 100=1.19228 sp. gr., or 25 per cent salt.

[2] The freezing point of a brine is commonly understood to mean the temperature at which ice begins to appear in it. In the solutions stronger than 22.42 per cent salt, salt, instead of ice, separates.

To conform to Ottesen's principle it is necessary to keep the brine in rapid motion. If agitation is not sufficient the mass of brine as a whole may be at its "freezing point," while the brine film in immediate contact with the fish may be so warmed up as to be several degrees above the "freezing point" and penetration may take place. For the same reason the quantity of brine must be sufficiently large, in proportion to the amount of fish present, so that the reserve ice is sufficient to take care of initial freezing. (Each pound of mush ice present will, in thawing, absorb 144 B. t. u. of heat from the fish.) Precooling the fish before they are immersed in the brine is also assumed to reduce the amount of penetrating salt.

Amount of salt penetration.—The amount of penetration of salt into fish has been studied experimentally by various investigators. Ehrenbaum and Plank froze large and small haddock in brine of 23.66 per cent salt, which dropped from 3.6 to 5.1° F. below zero during the freezing. Under these conditions crystals of salt were separating from the brine. Salt was determined in the surface tissues to a depth of 5 millimeters (⅕ inch) before and after freezing. The results are shown in Table 21.

TABLE 21.—*Penetration of salt in haddock frozen in brine*

	Salt in 5 millimeters of surface	
	Before freezing	After freezing
	Per cent	*Per cent*
Large haddock	0.11	1.57
Small haddock	.17	2.05

A similar trial was then made on fish in brine of 15 per cent salt at 11.1° F. above zero. Under these conditions crystals of water ice were separating from the brine. Salt was determined in the outer portion of the haddock before freezing, and one was wiped dry and immersed in the brine while the other was immersed wet. The results of this experiment are given in Table 22.

TABLE 22

	Not frozen	Frozen after wiping dry	Frozen wet
[illegible]	0.09	0.38	0.45

Alsberg and Field[1] investigated the penetration of salt in brine freezing of several common American fishes. Their conclusions, supported by several tables of analytical data, follow:

Whitefish, flounders, herring and whiting were frozen in chilled brine under different conditions to determine the various factors which influence the penetration of salt into the outer tissues of the fish. To assist in the determination of the degree of salt penetration, the skin and two successive layers of muscular tissue just beneath the skin were analyzed for their content of penetrated salt. The successive layers examined were usually one-eighth of an inch in depth, a few being three thirty-seconds of an inch thick. It was found that—

1. Salt penetrated perceptibly into the skin and superficial muscular tissues of the fish under all conditions, the amount not being sufficient, however, to affect the taste of the cooked product.

2. During the process of freezing the above species of fish under various conditions the outer muscular layer one-eighth inch in depth absorbed from 0.32 to 6.22 per cent of salt on the dry basis, the average being 2.88 per cent.

3. In a few instances the amount of salt absorbed by fish frozen in brine at its freezing point was slightly less than that which occurred when the brine temperature was several degrees above this point. In the majority of cases, however, no such temperature influence could be observed.

4. Whole fish were frozen in brines of different concentrations but at the same temperature, no consistent differences in the amount of salt absorbed by the fish could be noted.

5. Fish which had been precooled to near 32° F. before immersion in the brine did not take up as much salt as those which were at atmospheric temperature at this time, the absorption in the former case being 35 to 65 per cent of that in the latter.

[1] E. B. Alsberg and E. Field, "The preservation of fish frozen in chilled brine. I. The penetration of salt." Journal of Industrial and Engineering Chemistry, vol. 13, pp. 827-829. Easton, 1921.

6. The amount and rate of penetration of salt into the tissues of fish varies with the species. In weakfish and flounders the greater part of the salt which can be found in the superficial tissues at the end of a two-hour immersion in brine entered during the first 30 minutes. The absorption in the case of whiting and herring was more gradual, continuing rather uniformly during the two hours.

7. Inequalities in the fat content of the subcutaneous and body tissue of the fish are responsible in large measure for the difference in the susceptibility to salt penetration possessed by fish of the same species and by those of different species.

Stiles[47] gives several tables of analytical data, of which one is reproduced here as Table 23, showing the influence of the length of time of immersion on penetration of salt in different parts of pike.

TABLE 23.—*Influence of time of immersion on penetration of salt*

Region of fish	Salt in fish after immersion in 21 per cent solution at 2.3° F.	
	5 minutes	1 hou
	Per cent	*Per cent*
Near body cavity	0.17	0.76
Muscle tissue just under the skin	.22	.29
By the wall of the body cavity	2.51	3.51

When the fish are just removed from the brine any excess of salt will be in the skin and immediately underlying tissues. In time this salt seems to diffuse slowly throughout the fish and in this way becomes unnoticeable. Almy and Field observed that salt will even penetrate a block of ice and diffuse toward its center when the block is immersed for two hours in brine, even though the brine is at its freezing point.

Practical importance of salt penetration.—Salt, being a harmless substance, is of practical importance only insofar as, in penetrating, it (*a*) salts the fish excessively for taste, or (*b*) prevents glazing. It is not observed by any of the investigators that any fish have been too salty for taste except where flounders (a thin fish with large surface) were frozen in brine far too strong and too warm. Prevention of glazing, however, is of more consequence. It has been discovered independently by two or three investigators (including the present writer) that brine-frozen fish, if the penetration of salt is held to small proportions, can be glazed by washing the brine from the surface before the glaze is applied.[48]

This washing may be done either by moving the fish under fresh water or by spraying the suspended fish with fresh water.[49] It was found possible satisfactorily to glaze fish that had been frozen in brine without crystallization of ice. The Booth Fisheries Co. in Seattle, Wash., glazed smelt after freezing them in brine, washing them off, placing them in a cold room for awhile, then applying the

[47] "The preservation of food by freezing, with special reference to fish and meat," by Walter Stiles. Department of Scientific and Industrial Research, Food Investigation Board, Special Report No. 7, 186 pp. London, 1922.

[48] See "Refrigeration in the fish trade," by W. E. Warner. Cold storage and Produce Review, Vol. XXX, 1917, pp. 105–114. London.

[49] H. F. Taylor, U. S. Patent 1468050, Sept. 18, 1923.

glaze with fresh water.[50] Another effect of penetrating salt is to give the tissues of the fish a firmness superficially resembling rigor mortis. Fish may be soft and flabby before they are frozen in brine, yet after freezing and even after a long period of storage, when they are defrosted, they have a firmness or rigidity that might easily be mistaken for the rigor mortis of perfectly fresh fish. It may be distinguished from true rigor mortis by the fact that, while true rigor disappears after a short time, leaving the fish soft, firmness produced by penetrating brine persists for days, even until decomposition is well advanced.

PRACTICAL APPLICATION OF OTTESEN'S METHOD

In practical application Ottesen uses methods similar to those of Rouart, Rappleye, and Henderson—a tank of brine refrigerated by means of pipe coils connecting with a refrigeration machine. An agitating propeller keeps the brine in motion, and the fish are put in metal baskets and immersed in the brine. Ottesen's plants have been established at Esbjerg and Skagen, in Denmark; Henningsvaag, Norway; Gothenberg, Sweden; Åbo, Finland; and Ancona, Italy.

Two plants, operated under Ottesen's patents by Kühlfisch-Aktiengesellschaft Wesermünde, at Wesermünde and Cuxhaven, Germany, have been described by Walter Schlienz.[51] In the Wesermünde plant the fish are conveyed from the auction in boxes and dumped into washing tanks, where they are washed well in running water. The fish are then packed in wire baskets. By means of a crane these baskets are hoisted and placed in a shallow brine tunnel, or tank, 65 feet long, in which apparatus is provided to push the baskets slowly forward at a rate that is variable, so that the journey is made through the tank in from 1 to 3½ hours, according to the size of the fish. At the far end of the tunnel the crane again lifts the baskets and lowers them for a moment into a tank of running fresh water to wash off the adhering film of brine. The basket then passes through an aperture in a wall that separates the glazing room from the freezing room. A temperature of about 26½° is maintained in the glazing room. The glazing tank contains fresh water that is chilled to near the freezing point by the low temperature in the room. The fish, still in the basket, are immersed in this cold water for glazing and are transported to a storage room, where they are taken out of the basket, their heads cut off with a circular saw, and the fish packed 100 pounds to the box, the latter lined with paper. Ammonia compressors are used for refrigeration with electric motor drive. The plant has a capacity of 40,000 pounds per day, and provision is made for increasing this capacity to 160,000 pounds.

The Cuxhaven plant has the same capacity as that at Wesermünde and operates on the same general principles, with some differences in detail. The fish are packed in wire baskets that are rather long and narrow and suspended from both ends by a crane. The latter is

[50] See also, Petersen, U. S. Patent 1388298, 1921.

[51] Die Tiefkühlanlagen für Fische in Deutschland und der Handel mit Kühlfisch. Jahresbericht über die deutsche Fischerei, 1925, 23 pp. See also, M. Hirsch, Das Kühlfischwerk Cuxhaven. Zeitschrift für die gesamte Kälte-Industrie, Heft 4, Jahrgang 23, April, 1926; W. Schlienz, Die Neue Wege im Fischhandel. Deutsche Fischhandel, Interessenblatt für die gesamte Fischwirtschaft, Nr. 20–21, November, 1925. Berlin.

similar to our ordinary ice-pulling crane. There is a preliminary dipping or washing tank with running water. The brine tank is divided into eight compartments, each with its individual circulating pump. The baskets containing the washed fish are lowered into their respective compartments and the covers are put on. Operations are so timed that when the last basket is put in the first is ready to come out. The baskets are then successively dipped into the eighth, or fresh-water, tank, after which dipping they go to the glazing and packing room, which is held at 14° above zero, F. The packed fish are conveyed by elevators to upper floors.

Schlienz does not describe any means for maintaining constant composition or temperature of the brine.

Another room in the plant is provided with woodworking machinery for removing skins, fins, and entrails from the frozen fish, which are dressed for the preparation of fillets and steaks. The fillets are made either as entire fillets or cut into portions of from 4 to 8 ounces.

Schlienz says that it is necessary to reglaze the fish every 4 to 6 weeks, and that if this is done they can be kept without damage for 9 months. He finds difficulties, however, with fat fish like halibut, turbot, mackerel, and herring, in which the fat becomes rancid on storage. This is an understandable difficulty, since the temperature of 14° maintained in the storage rooms is well known in this country to be too high for that purpose.

The present writer has had opportunity to examine cod fillets of the small size prepared by this process, as shipped. They are in a wooden box of 25 pounds net weight, wrapped in 30 packages. The wrapper is paper, not parchmentized, not waxed, not printed, and held with a rubber band. Each package contains one or two pieces of a size, shape, and thickness that depends on the part of the fish from which it comes.

The pieces themselves are skinless and are made by clean cuts of the fish in the frozen condition, the cut surfaces being flat or squarish, and not at all ragged. There is a groove where the backbone was, suggesting that the bone has been removed with a half-round chisel, such as is used in wood turning. In cross-section the internal structure is free from crystals and is in excellent condition. There is some development of yellow color outside, a condition that always develops in frozen cod and haddock fillets unless preventive measures are taken. On being defrosted the fillets are markedly juicy, indicating a change in the hydration of the protein. The elastic, gelatinous consistency of fresh cod muscle has disappeared. When cooked the flesh is somewhat dry and rather coarser than that of fresh cod because of the change just mentioned. The flavor is good and no saltiness is observed.

Ottesen also patented [52] a brine with an organic substance (glycerin) added in order further to reduce its freezing point.

Glycerin and water mixtures of low freezing point are well known for use; for example, for automobile radiators. When glycerin is added to a salt brine the freezing point of the mixture is lower than would be that of the glycerin or salt alone with the water. The

[52] U. S. Patent 1532931, Apr. 7, 1925.

mathematical formulæ for calculating the freezing points of such mixtures have been studied by Fawsitt.[53]

It is claimed for such a mixture that a temperature as low as 25° F. below zero may be attained in practice, and that fish and meat may be frozen in such a brine without impairment of appearance or quality. Ice crystals do not form in the brine under the conditions followed in practice.

BULL'S METHOD

H. J. Bull, director of the fisheries research laboratory of the Norske Fiskereies Fremme, at Bergen, Norway, devised a method[54] of freezing fish in a circular brine tank with an inner chamber, wherein ice is placed. Salt brine is drawn downward through this ice by means of a propeller, and rises in the outer zone. In this latter zone are placed the shelves or baskets of fish to be frozen. He later patented[55] a method of brine-freezing fish by incasing the fish in molds of net or with openwork sides so that the brine could enter and come in contact with the fish. He employed several kinds of molds. One was a shallow wooden frame with sides of wire screen. The fish were packed in the frame, held in place by the screen, and frozen in brine. When the freezing was complete the screens were removed and wooden boards nailed in their stead to the wooden frames, completing a shipping box. Several such frames could be fastened together, making one large shipping package. Bull also used sheet-metal molds and made them of different shapes. From these the frozen cakes were removed and packed in boxes for shipment or storage.

FYERS'S AND WATKINS'S METHOD

In most of the newer methods of freezing fish the aim has been to freeze as rapidly as possible, other considerations generally being subordinated to speed. A. Fyers and W. P. Watkins[56] state that the brine-freezing method involving immersion of fish directly in very cold brine has been unsatisfactory "apparently because of the sudden lowering of the temperature of the fish when immersed in the cold brine." In their method the fish are first thoroughly washed in water preferably at about the normal atmospheric temperature. They are then put in a revolving perforated cylindrical drum inclosed in a fixed cylindrical chamber. Around the drum are pipes adapted to spray brine radially inwardly on the drum, so that some of the brine goes through the perforations and strikes the fish. At the beginning the brine is at normal atmospheric temperature, but is gradually lowered until it is at about 15° F., at which temperature the fish are treated further until they are frozen. The time required to reduce the temperature to 15° F. is about 2½ hours, and the further treatment at 15° is, in the example cited by them, about 2 hours, a total of 4½ hours.

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[53] "The freezing point of solutions, with special reference to solutions containing several solutes," by C. E. Fawsitt. Journal of the Chemical Society, Vol. CXV, 1919, pp. 790–801.
[54] British Patent 23126, Apr. 16, 1913.
[55] U. S. Patent 1201552, Oct. 17, 1916.
[56] British Patent 127404, 1919.

We have seen from the theory of brine freezing that brine that would be liquid at 15° F., at normal atmospheric temperature is far above its freezing point. Under such conditions penetration of salt is bound to be severe. Furthermore, there is no evidence that very rapid freezing or sudden subjection to low temperatures does any harm to the fish.

MANN'S METHOD

For purposes of freezing fish in brine, particularly on steam trawlers, Robert Mann covered by patent [57] apparatus comprising a deep, upright tank, opening above the deck forward but extending through the deck below, where the accessory machinery is located. The tank is filled with refrigerated brine. Openwork cages are provided, in which the fish baskets or containers are placed. This cage is lowered into the tank of brine from the main deck. The brine is refrigerated by a suitable refrigeration machine and is filtered. The arrangement of apparatus permits the freezing operations to be conducted from the main deck without obstruction by machinery.

HIRSCH'S METHOD

It will be recalled that in Ottesen's invention it was brought out that when fish are exposed directly to brine for freezing there will be some penetration of salt unless the temperature and concentration of the brine conform to certain specified requirements; namely, that the brine of any particular concentration less than 22.42 per cent of salt be at such a temperature that free ice will exist in it. It was also pointed out that while the required conditions might be met in the body of the brine as a whole, that which is in immediate contact with the fish may be warmed by the fish until some penetration of salt occurs. Ludwig Hirsh [58] avoids the formation of a slow-moving film of brine in contact with the fish by suspending or loosely piling them and showering them with brine. By thus preventing penetration he claims that other brine, such as solutions of calcium or magnesium chloride, may be used. He further provides that the fish may be given a glaze by means of a preliminary bath or shower of fresh water, the adhering water film freezing at once when the cold brine touches it. It seems to the present writer unlikely that such a film would really freeze to a glaze under the circumstances. Ottesen makes a similar claim in his patent.

GOËR DE HERVÉ'S METHOD

The first method to be devised for continuous freezing of fish in brine was that of E. de Goër de Hervé,[59] who devised a long tank for brine through which the fish were moved by a combination of wire netting to hold the fish submerged and paddles to keep them in motion. The inventor describes the apparatus and its operation as follows:

> The apparatus consists of two endless chains on which is stretched an endless band of wire netting with a mesh small enough to retain the smallest fish

[57] British Patent 144368, 1920.
[58] German Patent 335871, Apr. 16, 1921.
[59] La Revue Générale du Froid et des Industries Frigorifiques, October, 1920, pp. 291–292.

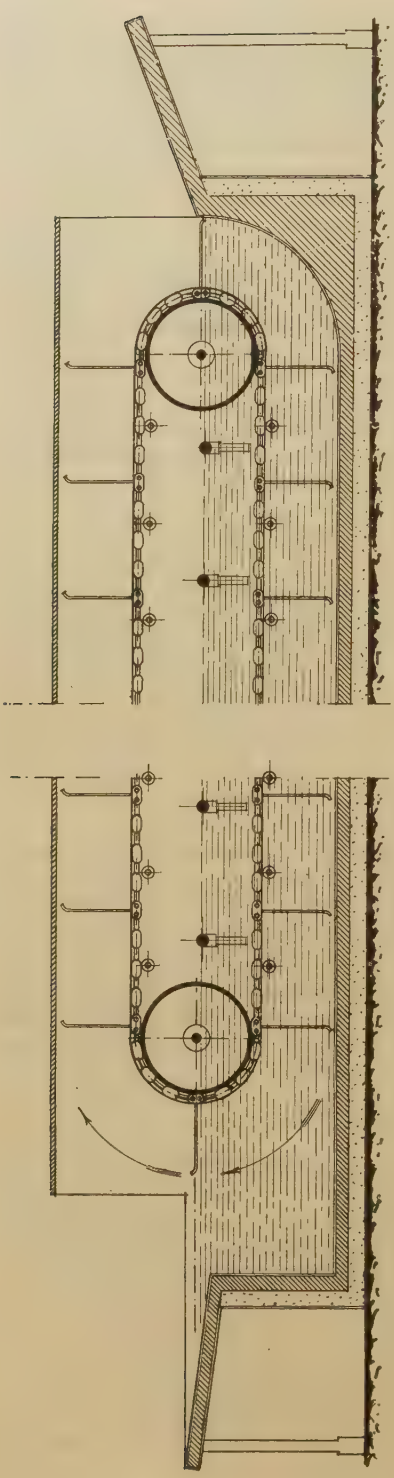

FIG. 30.—Goër de Hervé's method of freezing

without hindering the free circulation of brine. The endless chains and netting are supported by two drums, one of which is connected with a gear by which the whole system is set in motion.

At distances of 3 feet 6 inches the links of the chains carry light iron frames on which netting is stretched, thus forming a kind of paddle, the apparatus having to some extent the appearance of a caterpillar tractor, the paddles, however, being of exceptionally large size. The whole apparatus is immersed in a brine tank up to the axle of the drum.

At a small distance from the lower part of the endless net are placed lines of cocks with their apertures underneath, by which cold brine from a double-pipe brine cooler enters the tank at a certain pressure, causing sufficient agitation in the whole body of brine.

The drums, chains, and netting being set in motion at very slow speed, a crate of fish just landed from the trawler is emptied in the tank at one end; the fish are caught beneath a paddle and gently dipped into the brine. When the paddle has passed the vertical plane, the fish, on account of their density being less than that of the brine, begin to float in the liquid and adhere to the underside of the netting. The motion caused in the water by the lines of cocks prevents the fish forming thick masses from which heat could not be eliminated and spreads them thinly underneath the netting. The fish are thus slowly moved in gently agitated brine from one end of the tank to the other, where they arrive frozen hard; they are then taken out, packed in convenient cases, and placed in cold storage. The motion of the netting and the paddles is so slow and gentle that in no case can the skin or scales of the fish be injured, and special fittings are provided with a view to prevent any fish being caught and pressed between the paddles and the walls of the tank.

Except at the ends, where the fish are dropped in or picked out, the tank is covered to avoid any undue loss of cold, and, of course, the whole external surface of the tank is thickly insulated. The excess of brine coming from the tank is passed through a settling tank, then pumped through a filter to take out dirt, scales, or mucus, after which it passes through the brine cooler and back again to the freezing tank. The output of a tank supplied with fish up

to 10 ounces in weight, with brine at 0° F., is about 1 ton per hour, the only hand labor needed being one unskilled man at each end, who can easily attend to three tanks, so that the cost of labor in this process is exceedingly small.

The cost of refrigeration is reduced to a minimum, for if the insulation is good the only leakage is that at the ends, which is, of course, unavoidable.

The speed of the drums may be increased in case the tank should be used for chilling fish instead of freezing, in which case the output is, of course, much larger. The standard tank covers a floor space of 83 feet by 7 feet.

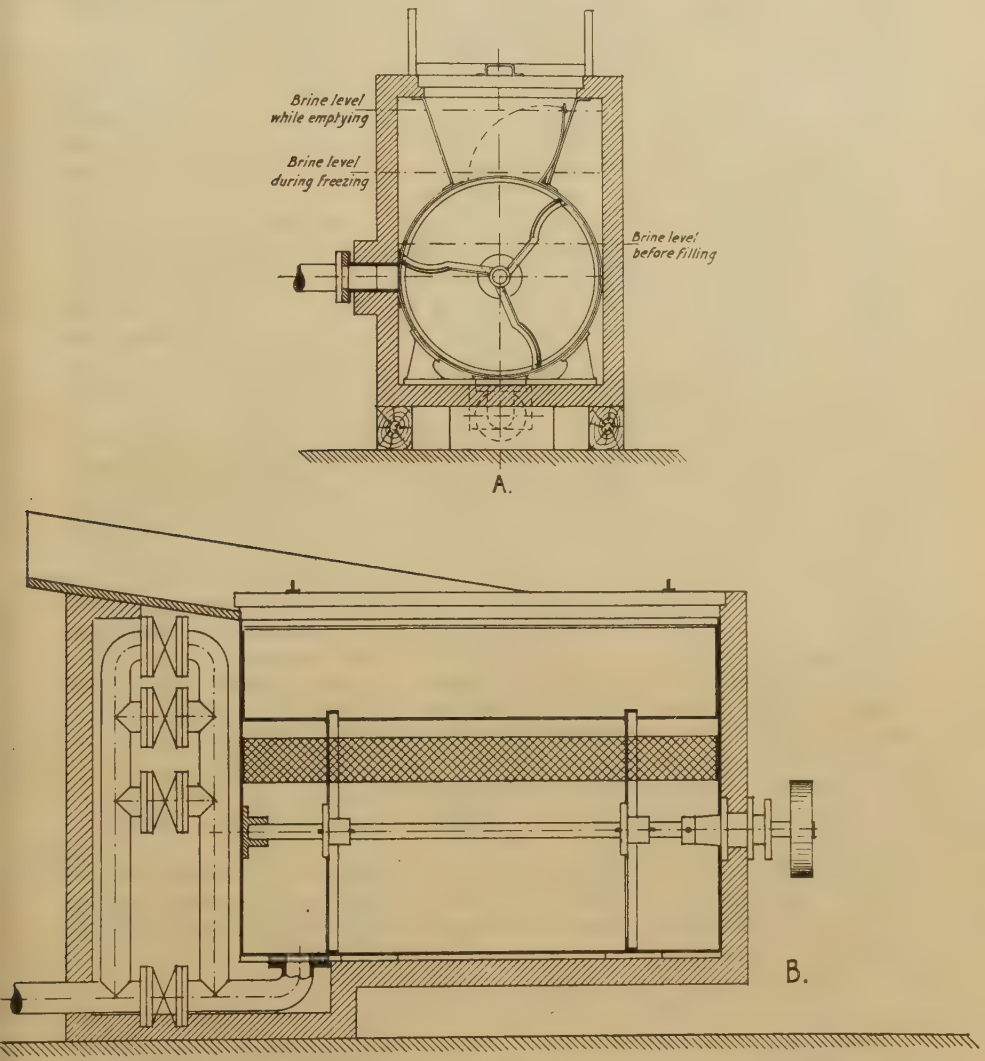

FIG. 31.—Piqué's method of freezing herring. A, cross section. B, longitudinal section

PIQUÉ'S METHOD

The British Fish Preservation Committee, under the Food Investigation Board, conducted extensive research work in methods of freezing fish, particularly by means of brine. One of the results of this

work was the design of an apparatus for practical use in freezing fish, especially herring, in large quantities.[60] In this apparatus, as in that of Goër de Hervé, the fish are moved about in brine, but in a revolving motion rather than a forward motion. In its simplest form (fig. 31) the apparatus is a tank containing refrigerated brine. In the tank is mounted a cylindrical drum of wire netting or perforated sheet metal. Three baffles are mounted on a revolving spindle, arranged to revolve within the drum. A chute is provided for loading the freezer from the top when the door is open. Valves are provided so that the brine may be kept at any one of the three levels—one within the drum, another just above it, and the third near the top of the tank. To fill the freezer, the brine is lowered until its surface is within the drum, and with the door open the fish are put in at the top and dropped into the drum. The door is then closed and the brine level caused to rise by closing the lowest valve. When the brine is at this level, the drum is revolved by an external source of power. The baffles or paddles carry the fish around and around in the drum. When the fish are fully frozen the drum is stopped, the door opened, and the brine caused to rise farther in the tank by closing another valve. The fish now rise to the top from the compartments and are scooped out. Upon slow revolution of the revolving baffles the fish in the other compartments likewise rise to the top.

A larger apparatus makes use of three or more cylinders of netting or perforated sheet metal, 3 feet 3 inches in diameter and 7 feet long. The cylinders have a door that swings on hinges and extends part of the length. Inside the cylinder are three baffle plates of galvanized sheet iron. The cylinder is mounted on a spindle with a gear at one end. The cylinders are filled about five-eighths full of fish—that is, about 1,870 pounds to each—and are lowered into the tank containing the cold brine, when the spindle ends rest in bearings. They are now caused to revolve, when the baffles not only keep the fish in motion but also serve as propeller blades, which renew the brine in the cylinder. The cylinders are moved by an endless chain, and one may be removed without disturbing the others. This apparatus has a capacity of about 2½ tons, which, in the case of herring, freezes in 50 minutes. Floor space required is 16 feet 6 inches by 9 feet 8 inches. Such a plant was built and operated at Billingsgate, England.

Another form of the apparatus makes use of the cylindrical drums which are loaded at one end, conveyed mechanically downward and forward through the brine, revolving as they travel, emerging and rising at the other.

NEWTON'S METHOD

J. W. Newton, of Los Angeles, Calif., striving for a plant that could be inexpensively constructed and simply operated, designed a

[60] Department of Scientific and Industrial Research, Food Investigation Board. Special Report No. 4, Interim Report on Methods of Freezing Fish, with special reference to handling large quantities in gluts. 50 pp. London, 1920. Piqué, J. J., and the Imperial Trust for the Department of Scientific and Industrial Research, British Patent 154250; Piqué, U. S. Patent 1431328, Oct. 10, 1922; and W. B. Hardy, Canadian Patent 212879, June 19, 1923.

tank[61] divided into compartments. The larger compartment is the brine chamber for freezing fish; another compartment with a screen at the bottom is for cracked ice. Adjacent to this is a salt compartment with perforated bottom. The brine is drawn from under the ice in the ice compartment, and the greater part of it is pumped through a distributing feeder into the fish-freezing compartment. A branch of this discharge line passes into the bottom of the salt chamber and delivers brine upward through the salt. This brine spills over into the ice compartment, as does also the overflow from the freezing compartment. The brine flowing through the ice[62] is thus made up of (*a*) the warmed, and therefore unsaturated, brine returning from the fish compartment, and (*b*) a smaller quantity of approximately saturated brine from the salt chamber. The mixture of these two brines then passes through the pump and to the fish. By this means the brine striking the fish can not be saturated, and the maximum rate of

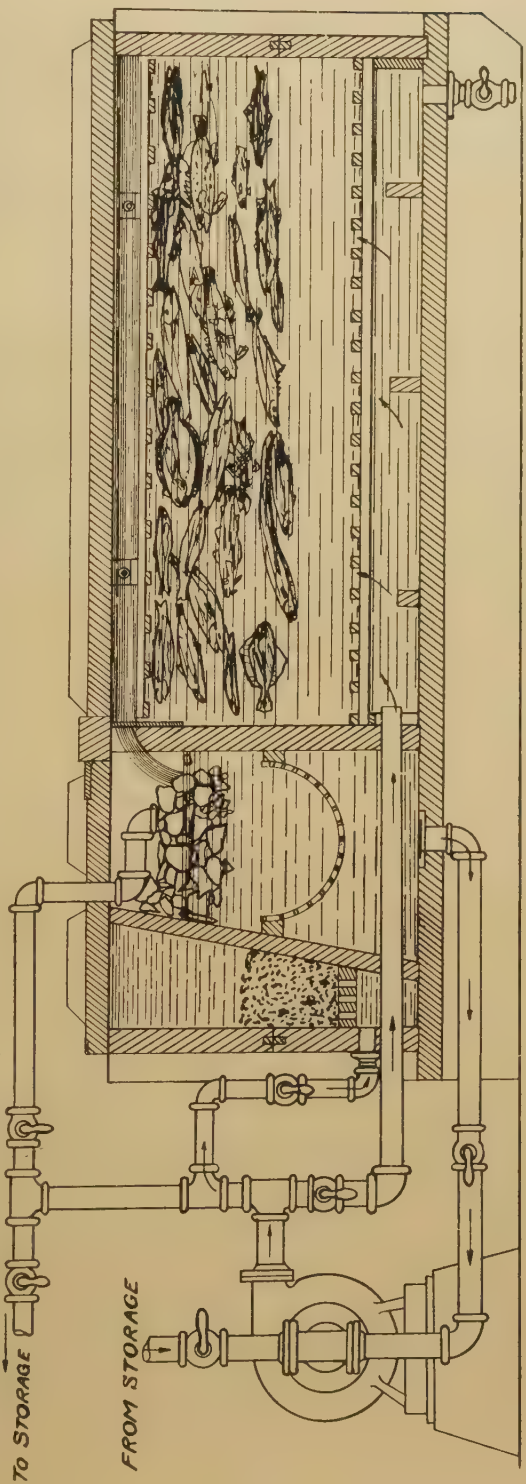

FIG. 32.—Newton's method of freezing fish in brine

[61] U. S. Patent 1547258, July 28, 1925.

[62] See also Dahl, U. S. Patent 1177308, Mar. 28, 1916.

liquefaction of ice and consequent absorption of heat can not be attained, as it could more nearly be attained if all the warmed brine returning from the fish passed through the salt before it struck the ice and after its passage through the ice chamber went to the fish again.

In operation ice and salt are put in their respective chambers and the apparatus is filled with brine. The valves are adjusted to provide the flow of brine and the pump is started. When the proper freezing temperature of brine is reached the fish are put in the freezing tank, where they remain until they are frozen.

TAYLOR'S METHOD

It is now some 36 years since freezing of fish in direct contact with brine was first proposed. In that time a dozen or more ways of doing it have been brought forward, and activity has been particularly marked in this field in the past 10 years. The advantages and difficulties of brine freezing are now apparent.

Fish frozen in brine, or by any sufficiently rapid method, undoubtedly are far superior to air-frozen fish in internal quality, because damage by internal crystallization is avoided, juices are saved on thawing that would be lost from air-frozen fish, autolysis is not so great, and the general appearance of the fish is better. By direct contact of brine with the fish the rate of extraction of heat is greater than it is in indirect contact, where the fish are inclosed in containers. Plank [63] has pointed out theoretical reasons for securing rapid freezing by direct contact with brine at a moderate temperature with the goods to be frozen, in preference to the very low temperatures of brine not in contact. Also, where contact with brine is immediate there is a sterilization of the surface tissues of the fish that is of practical value. The difficulties arising from penetration have been largely overcome by discovery of the physical principles that govern it and methods of reducing it to a minimum.

The barriers in the way of widespread adoption of direct brine freezing are largely mechanical. Where tanks are used for immersion of fish the volume of brine in proportion to volume of fish is large, almost prohibitively so where very large quantities of fish must be frozen. When fish are immersed in a tank of brine circulation of the main body of brine may be brisk, yet a very slowly moving film of brine will be in immediate contact with the surface of the fish, warming and causing excessive penetration of salt. Fish are of lower specific gravity than the brine, consequently they float and get out of the main movement of brine, crowding close together in a mass through which the brine does not circulate freely. In doing this they may also suffer considerable rubbing together, with consequent damage to snouts, fins, scales, and tails. Floating massed in brine, the fish assume curved shapes and do not pack advantageously when so frozen. Where fish are frozen in batches (as they are in all tank-freezing methods except Goër de Hervé's) the sudden charge of a large quantity of fish with rapid transfer of heat from fish to brine, unavoidably raises the temperature of the brine, with consequent penetration of salt, difficult or impossible glazing, and lack of uniformity of operation. Brine is corrosive, rapidly accumulating rust

[63] See p. 598.

from metal parts, and this rust may seriously discolor the fish. To the labor necessary for freezing must be added labor for washing and glazing, which, altogether, may be excessive.

If ice and salt are used as a source of refrigeration, it is impossible to maintain uniform temperature and concentration of brine, and refrigeration is wasted by discarding the excess of accumulating cold brine.

The present writer, while on the technical staff of the Bureau of Fisheries, after study of the theories involved and all the methods proposed for practice, approached the problem by first setting out the requirements that must be met by any entirely satisfactory brine-freezing method and then attempting to design a machine that would meet these requirements. The requirements for an entirely satisfactory brine freezer were conceived to be as follows:

1. Mechanical refrigeration should be used.

2. The brine should be maintained uniformly as near its cryohydric point as possible—that is, as near 6.16° F. below zero, and 22.42 per cent, by weight, salt.

3. To secure uniform operating conditions, operation must be continuous and not by batches.

4. The maximum rate of heat transfer should be secured by (*a*) exposing all the surface of the fish to the brine without obstruction, (*b*) flowing the brine with great rapidity, and (*c*) avoiding a sluggishly moving film in immediate contact with the fish.

5. The fish must be held straight until they become rigid.

6. Abrasion of fish by rubbing together must be avoided.

7. The quantity of brine used must be at a minimum and must not be wasted.

8. The brine must not be contaminated rapidly.

9. The fish must be washed thoroughly preliminary to freezing, preferably in running water.

10. The brine must be washed off and the fish glazed.

11. The machine must be capable of nice adjustment to fishes of different size, speed of freezing, etc.

12. It should be flexible—that is, applicable to as large a variety of fishes to be frozen as possible.

13. Metal working parts should avoid contact with corrosive brine, and rusting, in general, must be reduced to a minimum.

14. Labor for all operations should be at a minimum.

15. The machine must be suitable and practical for operation on a large scale.

The approach to the solution of these problems is as follows:

1, 2, and 3. If mechanical refrigeration is used, and if operation is continuous—that is, if the fish are fed continuously into the apparatus and are continuously withdrawn—maintenance of brine at or near its cryohydric point becomes possible. To secure continuity of operation the fish must be conveyed mechanically through the process from beginning to end.

4, 5, and 6. If the fish are suspended and sprayed with a violent spray of the brine, we secure all the desired conditions of exposing all the surface of the fish to the brine, flowing the brine with great rapidity, avoiding sluggish film on the surface, holding the fish straight as they freeze, and avoiding abrasion. 7. By using a spray

the quantity of brine is very small—only enough is required to keep a pump primed and fill all pipes. It can be discarded frequently without serious loss.

8 and 9. If a spray is used and the fish are conveyed mechanically through it, we need only add a fresh-water spray at the entrance of the apparatus, the entering spray to clean the fish of slime, blood, and surface bacteria and to avoid contamination of brine and minimize foaming.

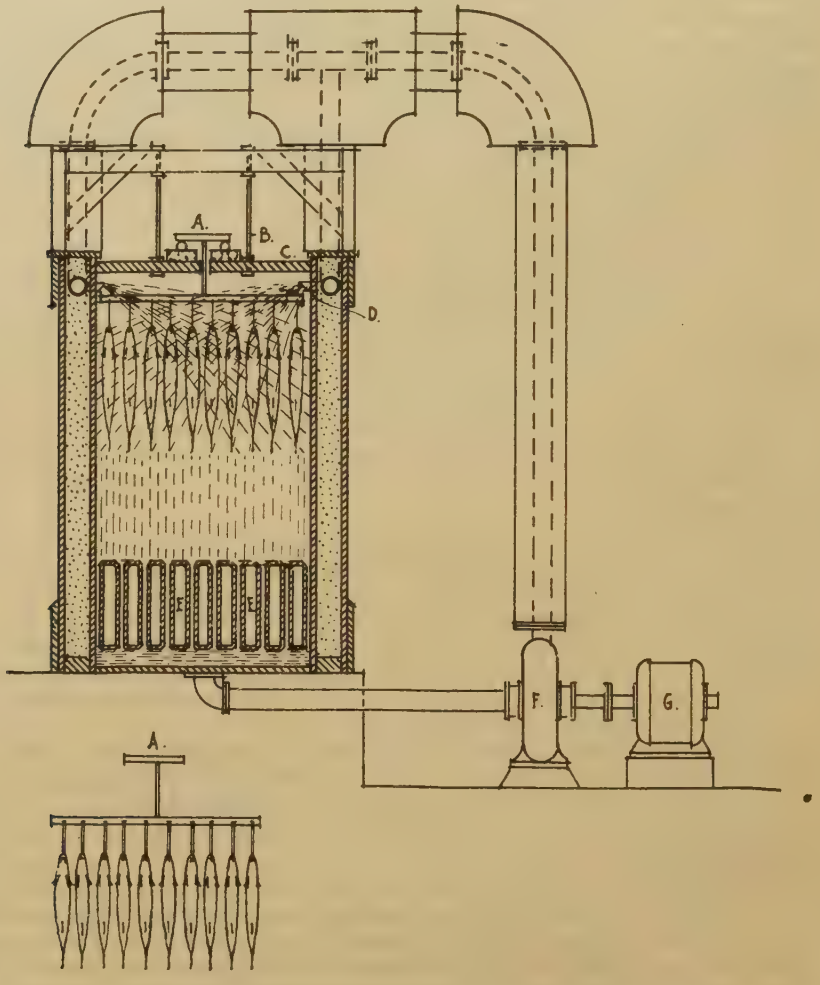

FIG. 33.—Taylor's freezing method. Cross section

10. To glaze the fish we need only to add a second fresh, cold water spray, or sprays, at the emergence end of the apparatus to wash off the brine and apply a glaze.

11 and 12. To secure flexibility and adaptability to different sizes of fish, the mechanical conveyer should be arranged for variable speed and the apparatus designed to take the largest varieties. Very small varieties can be inclosed in cans or other containers.

13. Avoidance of exposure of working parts to the brine is a matter of machine design and composition of brine to minimize formation of rust in the pipes, the same material, not galvanized, being used throughout.

14. By conveying the fish mechanically through the successive sprays of water, brine, and water, all necessary operations of washing, freezing, and glazing are done automatically, the only labor required being to put the fish in at one end of the apparatus and to remove them from the other.

The apparatus[64] takes the form of an insulated tunnel, say, 40 feet long by 4 feet wide, the dimensions being determined by the desired capacity. A mechanical conveyer operates in the top of the tunnel to convey horizontal bars through. On these bars the fish are suspended by head or tail. They hang thus and are frozen straight. The conveyer is adjustable for speed, so that large fish may be made to travel more slowly than small ones.

At the entrance end of the tunnel are provided sprays that give a violent shower of fresh water, washing the fish in clean running water. The fish then travel through a shower of brine at 5° or 6° below zero for, say, 32 feet, at a speed so adjusted as to freeze them by the time they reach the other end. When they emerge from the brine spray they pass under two fresh-water sprays. The first washes off the brine and, after draining a moment, the second applies the glaze. The fish then emerge washed, frozen, and glazed, and are ready to be packed.

The brine is pumped by a centrifugal pump and is cooled preferably outside the tunnel by a thermostatically regulated cooler, though it may be cooled in the tunnel, as shown in Figure 34. The time of travel of fish through the complete process varies from 15 minutes for smoked fillets of haddock to 3 hours for large salmon and halibut. Small fish, fillets, shrimp, oysters, and squid may be frozen by putting them in a can or other container and treating the containers like fish. Thus the flexibility of the apparatus is great.

A plant of this design and with a capacity of 15 tons of fish in 24 hours was constructed and operated in the Fishery Products Laboratory of the Bureau of Fisheries in Washington, D. C. It operated entirely satisfactorily under the experimental conditions.

FOAM IN BRINE

There is a tendency for foam to form in any brine freezer. The violent spraying of brine in this machine causes considerable formation of foam, a phenomenon that has required some study. The slime and blood on the fish, and other substances from the fish, if not washed off, are contributory causes. It was found also that the cruder grades of sea salt that we used in brine freezers contain a considerable quantity of an oily substance like petroleum. If the foam is collected, drained, and dried, a dark, sticky mass remains, partly soluble in ether and smelling like petroleum. It may be derived from decaying animals in the sea or may possibly be derived from ships.

[64] H. F. Taylor, U. S. Patent 1468050, Sept. 18, 1923; Canadian Patent 236588, Dec. 25, 1923.

The writer found by experiment (*a*) that the ratio of thickness of foam layer to depth of liquid brine obtainable with any particular brine is constant—that is, no amount of agitation of any particular specimen of brine will make a foam thicker than a definite maximum—and this ratio usually does not exceed 1 to 1; (*b*) that increasing contamination increases the ratio of foam thickness to brine depth; and (*c*) the constituents that cause foam remain in the foam. If the maximum foam is produced in a brine by agitation, and if the liquid brine is drawn off from the foam and this process is repeated two or three times, the foam-producing constitutents are removed and the brine does not foam until it is again contaminated. These facts point out a way to overcome difficulties from foam in brine freezers. The surface materials—blood and slime—that cause foam should be washed off. The brine vessel should be at least twice as deep as would be necessary for the liquid brine alone to allow for the gathering foam, and provision should be made for this foam to be carried away, draining free of the brine meanwhile. The contaminating impurities are thus automatically and continuously removed from the brine. In the case of the spray freezer this foam overflows into the washing compartments at each end.

RUSTING OF METAL PARTS

This highly complicated subject has received much study by chemists, electrochemists, and engineers and can not be discussed at length here.[65] Briefly, the brine should, if possible, be kept slightly alkaline with lime or a small amount of caustic soda. This may not be practicable in the spray freezer because of the intimate contact of the brine spray with air and consequent rapid absorption of carbon dioxide. Neither is this treatment effective in tanks where fish are in contact with brine, because these alkalis react and combine with the fish flesh and with the slime and fats coming from the fish. The composition of the metals of which the apparatus is composed has much to do with corrosion, and there are several resistant alloys on the market that eventually may be used for making freezing apparatus. Among these alloys are Monel metal, duriron, and an aluminum silicon alloy.

RAPID FREEZING IN CELLS OR MOLDS

In the foregoing methods of freezing, the fish are in immediate contact with the brine during the freezing process. Immediate contact secures the advantage of the greatest possible effective surface and the best possible rate of transfer of heat for a given difference in temperature. On the other hand, as has been seen in the discussion, the composition of the brine is limited practically to a solution of salt in water, with which the lowest possible temperature attainable is 6.16° F. below zero, though by addition of small amounts of other substances this temperature might be lowered a few degrees. Also, difficulties arising from the penetration of salt into and interaction with the tissues of the fish have necessitated serious considera-

[65] For a full discussion of corrosion see "Symposium on corrosion," papers by 19 authors, Industrial and Engineering Chemistry, vol. 17, April, 1925, pp. 335–392, Easton. See also "The corrosion of metals by refrigeration brines," by E. P. Poste and Max Donauer. The Milk Dealer, February, 1923; "The chemistry of the brine tank," by B. S. Hull. Ice Cream and Refrigeration, March, 1923; "The chemical treatment of refrigeration brines to prevent corrosion," by E. P. Poste. The Dairy World, December, 1924, pp. 41–46.

tion. Lower temperatures are possible with solutions of other substances. With calcium-chloride brine a temperature of 67° below zero is possible, and 28.5° below zero may be attained with magnesium chloride. These brines and other liquids of low freezing point can be used provided the fish are protected from direct contact with them by being inclosed in some impervious container, preferably a good conductor of heat. When fish are so frozen, the surface is free from any trace of foreign salt and may be glazed as easily as air-frozen fish. Numerous methods based on these facts have been proposed or practiced from time to time, and some of the more promising ones are in successful practical use.

As will be seen in the discussion, the difficulties in freezing in cans or molds arise from (*a*) less perfect contact of the fish with the brine than is obtained in direct brine freezing, and (*b*) lack of flexibility because of difficulty of making cans or molds that conform to the shapes of many varieties of fish.

Usually several fish are packed close together in the mold. The surfaces in contact with one another are, of course, not effective for heat transfer, only the outer surfaces of the mass as a whole serving this purpose. This outer surface, not being uniformly flat, generally has incomplete contact with the walls of the mold. The rate of freezing in molds, therefore, is considerably lower for the same brine temperature than it is where the fish are in direct contact with the brine. To overcome this difficulty, recourse is had to the lower temperatures that are possible with calcium chloride brine. An objection to this procedure lies in the diminished efficiency of refrigeration machinery as lower temperatures are reached, expressed in terms of tons of refrigeration per horsepower, as it is generally recognized that refrigeration machinery becomes less efficient as the temperature lowers.

In ideal refrigerating machines the amount of work done is proportional to the difference between the temperature at which heat is absorbed and that at which it is rejected. We may say that the steeper the grade up which the heat must be pushed the more work is required to push it. The efficiency is expressed mathematically by the ratio $T_1 \div (T_2 - T_1)$ where T_1 is the cold side and T_2 the warm side, expressed in absolute temperature units. Table 24 shows these ratios for several temperatures commonly dealt with in refrigeration.

TABLE 24.—*Ideal efficiency of refrigerating machines*

Temperature at which heat is absorbed (evaporating ammonia), degrees Fahrenheit	Temperature at which heat is rejected (ammonia going to condenser), degrees Fahrenheit, and ratio of cold produced to work done by machine					
	50	60	70	80	90	100
−30	5.5	4.8	4.3	3.9	3.6	3.3
25	5.9	5.1	4.6	4.2	3.8	3.4
20	6.4	5.5	4.8	4.4	4.0	3.6
15	7.0	5.9	5.2	4.7	4.2	3.8
10	7.5	6.4	5.6	5.0	4.5	4.1
5	8.5	7.0	6.0	5.3	4.8	4.3
0	9.2	7.7	6.6	5.8	5.1	4.6
+10	11.7	9.4	7.8	6.7	5.9	5.2
20	16.0	12.0	9.6	8.0	6.8	6.0
30	24.5	16.3	12.2	9.8	8.2	7.0
40	50.0	25.0	16.7	12.5	10.0	8.3

To take an example: If brine is to be maintained at 25° F. below zero, the temperature of the evaporating ammonia may be 30° below zero. This, expressed in absolute units (238.59°), is T_1. If the condensed water is 75° F., we must maintain a temperature of, say, 80° in the compressed ammonia gas. This, also expressed in absolute units (299.64°), is T_2. The efficiency, $T_1 \div (T_2 - T_1)$, is 3.9; that is, 3.9 times as much energy will be handled in the form of heat as is expended in the form of work. If a temperature of 5° F. below zero is to be maintained, we may evaporate the ammonia at 10° below zero. If the condenser water is still 75° and the compressed ammonia 80°, the efficiency by ratio will be 5.3. At 25° below zero brine temperature the ideal efficiency is only about 74 per cent of what it would be at 5° below zero brine. This neglects actual inefficiency in the machine itself, friction, losses, and smaller amount of gas handled per piston stroke.

Apart from the diminished efficiency of the machinery and the economic factors involved, it has been pointed out by Plank [66] that these lower temperatures are objectionable in their effect on the tissues of the fish. The juices of fish contain mineral salts and colloid substances. Because of their presence a very low temperature [67] (around 75° C.) is necessary to cause all the water to freeze solid. At a temperature warmer than this more and more of the water is left in the tissue substance. If a fish originally containing 75 per cent of water is frozen at 5° F., there remains about 13 per cent water of the 75 per cent still in the tissues unfrozen; while if frozen at 31° F. below zero only 2 per cent would remain—that is, the tissues would be almost completely dehydrated and would return, if at all, with much more difficulty to their original condition on defrosting. For these reasons Professor Plank recommends that speed in freezing be secured by direct contact and brisk circulation rather than by very low temperatures with less perfect contact.

Opposed to these objections are the advantages of compactness, convenience, and cheaper handling of cakes or blocks instead of individual fish, and the ease and perfection of glazing. Freezing in molds is particularly well suited to the freezing of fillets or steaks of fish, which readily conform to the shape of a mold and are more seriously affected by penetration of salt than round fish.

EARLIER METHODS

Among the earliest methods of freezing fish were those that involved the packing of fish in pans with lids,[68] which were embedded in cracked ice and salt. Hesketh and Marcet, who were also pioneers in brine freezing, covered in their patent [69] the freezing of perishables by placing them in compartments, boxes, or cells surrounded

[66] R. Plank, "Theories concerning the changes taking place in the cell membranes of animal flesh during the process of refrigeration." Ice and Cold Storage, October, 1925.

[67] H. W. Foote and Blair Saxton ("The effect of freezing on certain inorganic hydrogels." Journal, American Chemical Society, Vol. XXXIX, pp. 1103–1125. Easton, 1917. See also ibid., Vol. XXXVIII, p. 588, 1916.) have shown that the jellylike consistency also has an effect of lowering the freezing temperature, the contained water being in the capillary condition.

[68] D. W. and S. H. Davis, U. S. Patent 161596, Apr. 6, 1875. Referred to, also, in D. W. Davis, U. S. Patent 709751, Sept. 23, 1902.

[69] British Patent 6117, Apr. 9, 1889.

by a cooling medium. In the same year Douglas and Donald [70] invented the freezing of fish and the like by inclosing them in bags, which were put in ice cans and surrounded by water. The whole was frozen together, so that the fish were incased in a block of ice.

FRIEDRICHS' METHOD

This idea of freezing fish by putting them in tapered cans and lowering the cans in cold brine, according to the well-known practice of making ice, was revived in 1915 by Martin Friedrichs [71] in Hamburg, Germany. Friedrichs adapted it particularly to the freezing of eels. The eels were hung on a support and lowered into

FIG. 34.—Petersen's method of freezing. The panned fish are transferred to the freezing molds. Courtesy, Bay City Freezer

a deep, narrow, tapered can and were surrounded by water. The can was then lowered into an ice-brine tank and the contents frozen solid. When the contents were frozen the can was withdrawn from the brine and the block was removed and stored at a temperature a few degrees below the freezing point of water. It was reported that eels frozen and protected in this way kept perfectly for a year or more. Provided a lower temperature was used in storage, they should keep almost indefinitely.

PETERSEN'S METHOD

P. W. Petersen, of Chicago, using a tapered freezing can, worked out many details of its application to the commercial freezing of

[70] British Patent 20614, 1889 (Feb. 8, 1890).
[71] Die Friedrichs'che Aal-Gefriermethode. Die Kälte-Industrie. XII Jahrgang, Heft 1/3, pp. 3–4. Hamburg, 1915.

fish.[72] The method applies to freezing fish in cakes and to freezing them singly.[73]

FREEZING IN CAKES

For this purpose Petersen uses a narrow, deep, tapered can, constructed of heavy sheet metal, of various dimensions to suit different sizes of fish. For fish from 1½ to 10 pounds the dimensions are such as to produce cakes 28 inches long, 18 inches wide, and 3¾ inches thick. For smaller fish cans of the same length and depth but 2 inches thick are used. The can is somewhat deeper than the width of the cake, and when it is partially immersed in the brine

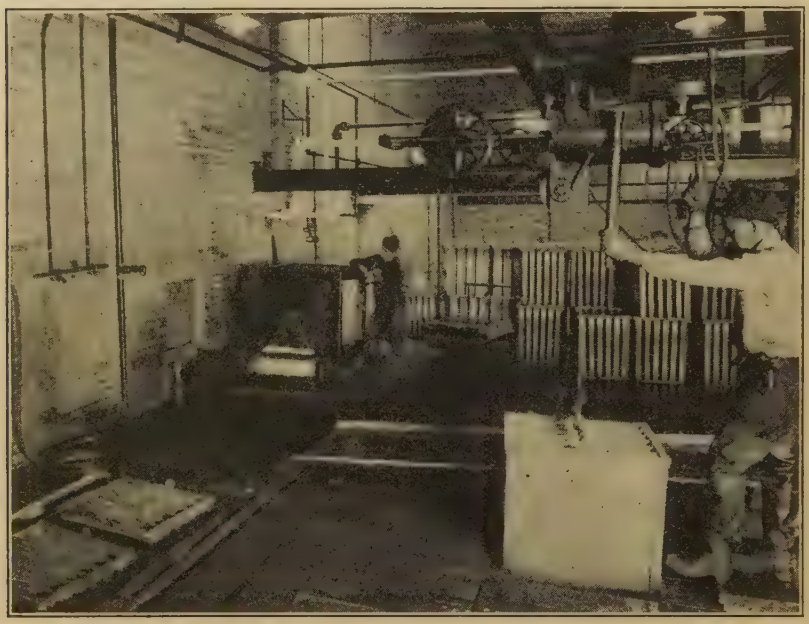

FIG. 35.—Petersen's method of freezing. The freezing molds are lowered into the brine tank. The dump for removing the cakes in center background. Here they pass through the glazing trough into a cold packing room. The pan with wheels on a rail is to catch brine drip from the freezing molds when they are brought up. Courtesy, Bay City Freezer

the contained fish are all below the brine level. To facilitate handling the cans are attached to iron frames in batteries of 4 of the larger cans or up to 8 of the smaller.

For packing fish in the cans scoop-shaped temporary receptacles are used—shallow pans suggesting a dustpan or snow scoop, provided with a handle. These scoops are designed to fit in the freezing pans. The fish after being washed in the usual way are packed in these scoops. A frame of cans is turned on its side and the scoops of fish put in the cans. The frame is then upended and the

[72] P. W. Petersen, U. S. Patent 1422126, July 11, 1922; reissue 15083, Sept. 24, 1923. C. J. Thompson and P. W. Petersen, U. S. Patent 1509850, Sept. 30, 1924. P. W. Petersen, U. S. Patents 1528890 and 1528891, Mar. 10, 1925.

[73] See "A modern fish-freezing plant," by P. W. Petersen. Refrigerating Engineering, June, 1924. New York; also "Modern methods of freezing fish." Same journal, July, 1922.

scoops pulled out, leaving the fish in the cans arranged in an orderly manner. In this position the fish in the bottom of the can are under pressure from those above. This has the effect of reducing the space occupied by the fish, with consequent saving of storage space, and also secures the good contact with the can necessary for rapid freezing. It has the disadvantage, however, of distorting the shape of the fish.

When the frame of cans is filled with fish, it is lifted, by an electric hoist that moves on rails over the freezing tank. This is a tank that resembles in all essentials an ice-making tank. It may be provided with refrigerating coils or an external shell cooler for refrigerating the brine, the brine being kept in motion among the cans by an agitator. The frame of cans is lowered into the brine so that

FIG. 36.—Petersen's method of freezing. The fish emerge from the glazing tank into a cold room, where the glaze sets and the cakes are boxed. Courtesy, Bay City Freezer

the open ends project above the brine level. A hatch lid covers the can.

As calcium chloride brine is used, the temperature may be very low, with consequent rapid freezing. Peterson maintains a temperature as low as 25° or 30° F. below zero, but as brine is not in contact with the fish any suitable temperature may be used. Cakes 4 inches thick, in brine at 20° to 25° F. below zero, freeze in about 2½ hours. If allowance is made for time of dumping, glazing, and interruptions, 8 freezing cycles may be made in 24 hours, each frame of cans holding about 250 pounds. The capacity of a freezer is measured, of course, by the number of cans the tank will accommodate.

When the fish are frozen the hatch lid is taken off, the hoist attached, and the frame of cans pulled out. To prevent any drip of brine to the floor, with possible entrance into the fish cans in the tank, a pan, mounted to roll on rails over the tank, is brought

under the lifted frame of cans. The frame is then conveyed to the dump. It is first immersed in a well of water (the warm water from condensers is recommended for this) to loosen the cakes and is then placed in a swivel-mounted dump and turned over. The cakes slide out into the glazing trough. This arrangement allows the frozen cakes to fall directly into the glazing water, which breaks the impact and avoids the damage that would be done the fish if they should fall on the floor.

FIG. 37.—Petersen's method. Cakes of fish frozen in molds. Courtesy, Bay City Freezer

The glazing trough is built through an opening in the wall that separates a cold packing room from the freezing room, one end being in the freezing room and the other in the cold packing room. The fish cakes float through the glazing trough, take on a glaze, and are removed in the cold room and packed.

The entire operation is practicable and simple and undoubtedly produces frozen fish of excellent quality. Where the sizes and

shapes are not excessively varied, a limited number of cans should serve; but where these vary greatly, as often occurs in public warehouses, especially those that freeze sea fish, a variety of sizes and shapes would be necessary. The larger kinds of fish do not pack to advantage in these cans, the difficulty being to secure contact with the sides of the cans. For this work Peterson has designed specially shaped freezing receptacles.

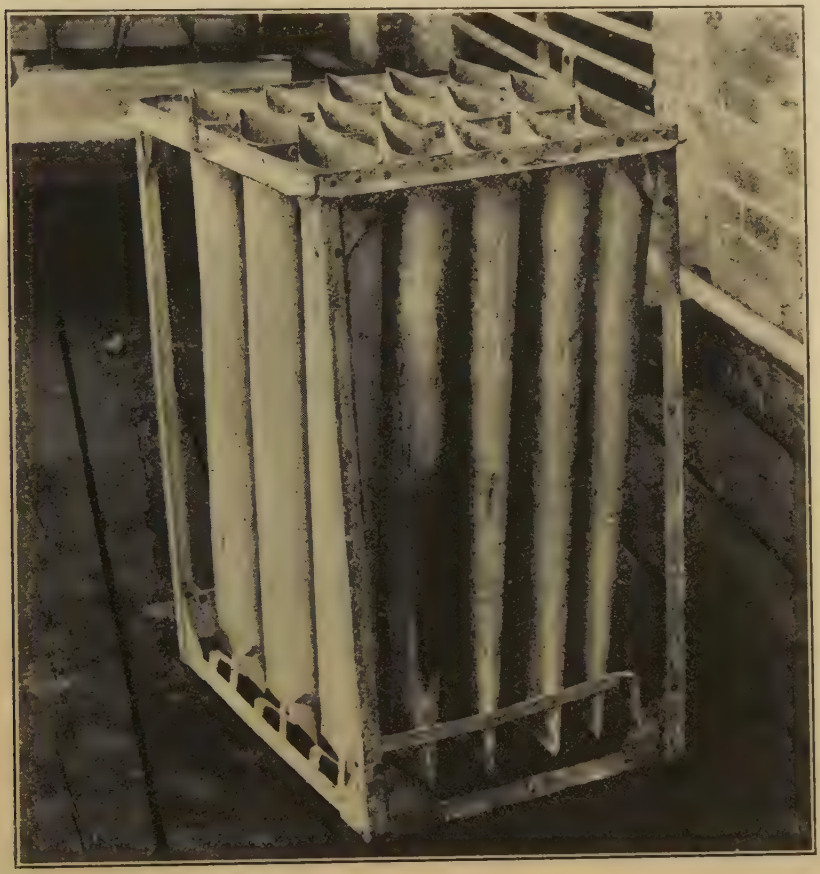

FIG. 38.—Petersen's method for freezing fish singly. The fish are slipped, tails downward, into the thin metal sheaths

INDIVIDUAL FREEZING

Instead of cans for a number of fish, a sheathlike, sheet-metal container is used for individual large fish. The container is made by bending around a thin metal sheet after the fashion of a starched cuff and crimping and riveting the edges together. The bottom is made narrower than the top and is also sealed. This arrangement makes a sheath somewhat resembling the shape of a fish, the round side fitting the back and the sharp side the belly. The fish is put in, tail down, the metal being sprung open so as to exert a

slight pressure on the contained fish. For halibut a two-edged container is used. These sheathlike containers are mounted in batteries and otherwise handled in the same way as the cans for cake-frozen fish.

Fish frozen by this method (for which Peterson has coined the word, "keenkooling") are trim, straight, and, of course, take an excellent glaze. The bellies of dressed fish are closed. Here, again, the principal difficulty would be to have a sufficient variety of sizes and shapes to accommodate the general run of fish received at a fish freezer. There could scarcely be objection to the internal quality of fish so frozen unless on the academic ground suggested by Plank (p. 598) of freezing at excessively low temperatures. An excessively low temperature, of course, is not essential to Peterson's method of freezing, because any temperature may be chosen. The only reason for the low temperatures actually used is to secure the benefit of the

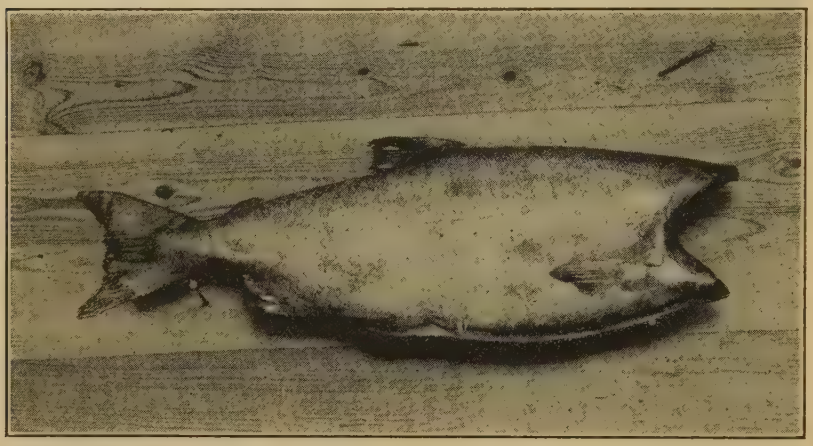

FIG. 39.—Petersen's method for freezing fish singly. Lake trout frozen in a thin metal sheath. Courtesy, Bay City Freezer

most rapid freezing possible. In this connection it may be noted that Peterson secures the necessary rapid freezing, not by particularly good contact with the refrigerant brine, but by a low temperature. It appears, in the absence of actual figures for comparison, that this method freezes at about the same rate in brine at 20° below zero as direct brine freezing does at 5° below zero. Refrigeration, as pointed out above, generally costs more per ton the lower the temperature.

Direct brine freezing seems to give the best possible contact but introduces difficulties of brine penetration, while indirect brine freezing avoids penetration but requires lower brine temperature to secure the necessary speed. The advantages or disadvantages are thus not all on one side.

KOLBE'S METHOD [74]

R. E. Kolbe, of Erie, Pa., has made an adaptation of the ordinary freezer pan to immersion in brine freezing without contact of brine

[74] "Brine freezing of fish," by Robert E. Kolbe. Ice and Refrigeration, vol. 70, pp. 205–206. Chicago, 1926.

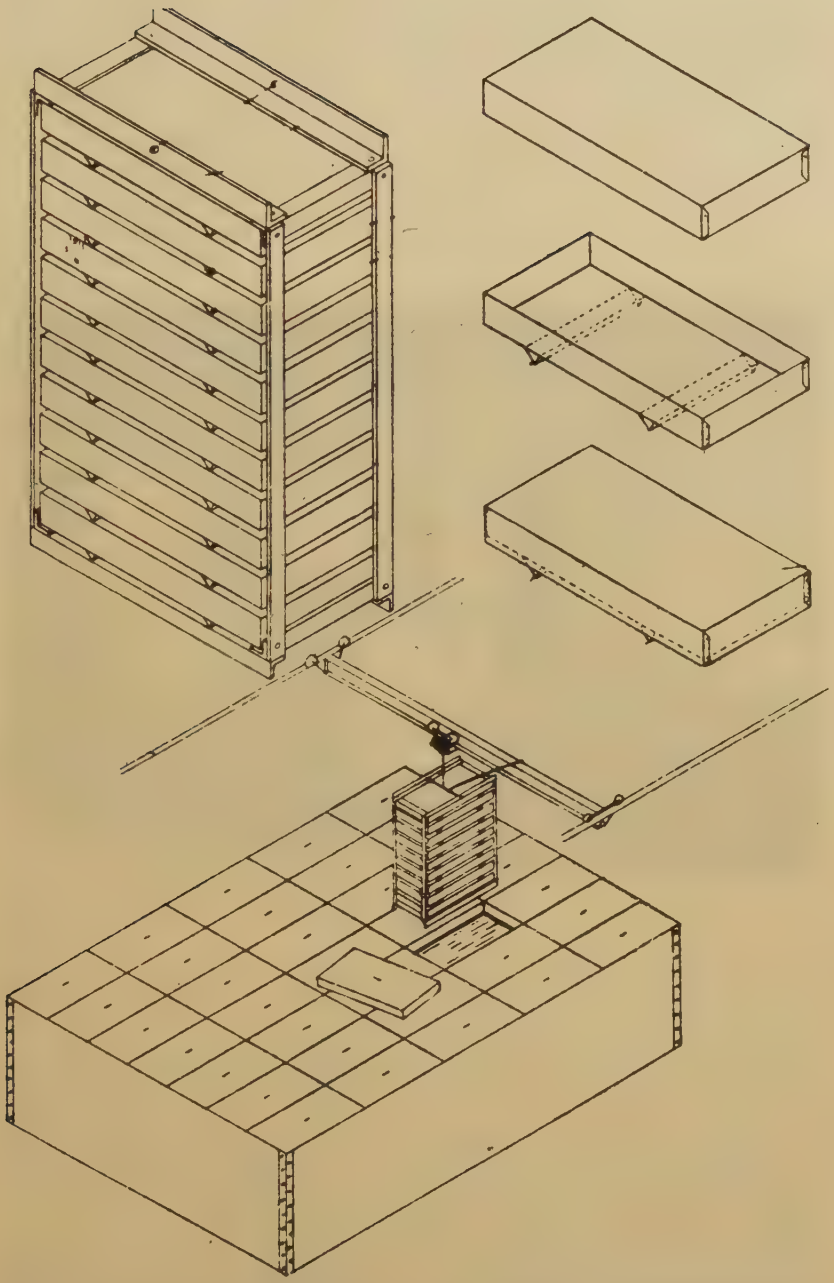

FIG. 40.—Kolbe's method of freezing. The fish are panned in metal pans, stacked in frames, and lowered into the brine tank. Courtesy, Kolbe Fish Co.

with the fish.[75] A plant is in operation at Port Dover, Ontario, on Lake Erie, with a daily capacity of from 12 to 20 tons of fish a day. Shallow pans in shape and dimensions similar to the ordinary air-freezing pans for Lake Erie fish, holding about 17½ pounds each, are provided with lids somewhat deeper than the pans. The pan itself has two V-shaped metal strips fastened to the bottom, so that when the pans are stacked, one on another, they are separated by the thickness of this strip to allow circulation of brine between. Twenty such pans, after having been packed with 350 pounds of fish in the ordinary manner of air freezers, are placed in a frame made of angle irons. This frame is lifted by a traveling overhead electric hoist, moved over the brine tank as in Petersen's method, and lowered

FIG. 41.—Kolbe's method of freezing. Frame of pans being lowered into brine tank. Courtesy, Kolbe Fish Co.

into the brine. The tank contains 9,400 feet of 1¼-inch pipe and 15,000 gallons of calcium chloride brine, chilled by ammonia and kept in motion by means of agitators.

The brine is prevented from entering the cans by air entrapped in each pan, as in the diving bell. The air entrapped is compressed in direct proportion to the depth to which it is lowered, and in direct proportion to the specific gravity of the brine. If, therefore, provision is made for a sufficient volume of air under the lid of each pan, the pan may be immersed to a considerable depth before the brine can reach the fish—hence a lid deeper than the pan.

Refrigeration is furnished by a 9 by 9 inch inclosed compressor driven by a 35-horsepower motor. When fish are not being frozen, some refrigeration is accumulated by mushing the large volume of brine. The brine, of course, may be chilled by pipes in the ice tank,

[75] U. S. Patent 1527562, Feb. 24, 1925.

as above stated, or in a separate tank. Also, the pans may be lowered into an empty tank, which is then filled with the cold brine; or, with proper care, they may be immersed directly into the brine.

When the fish are frozen the cans are lifted from the brine tank, drained briefly, and conveyed to another part of the floor, where they are showered with water to remove the brine and loosen the cakes of fish. The cakes are then removed, glazed, and packed in the usual manner. This method of freezing is at present used by its inventor's firm, principally for freezing ciscoes on Lake Erie.

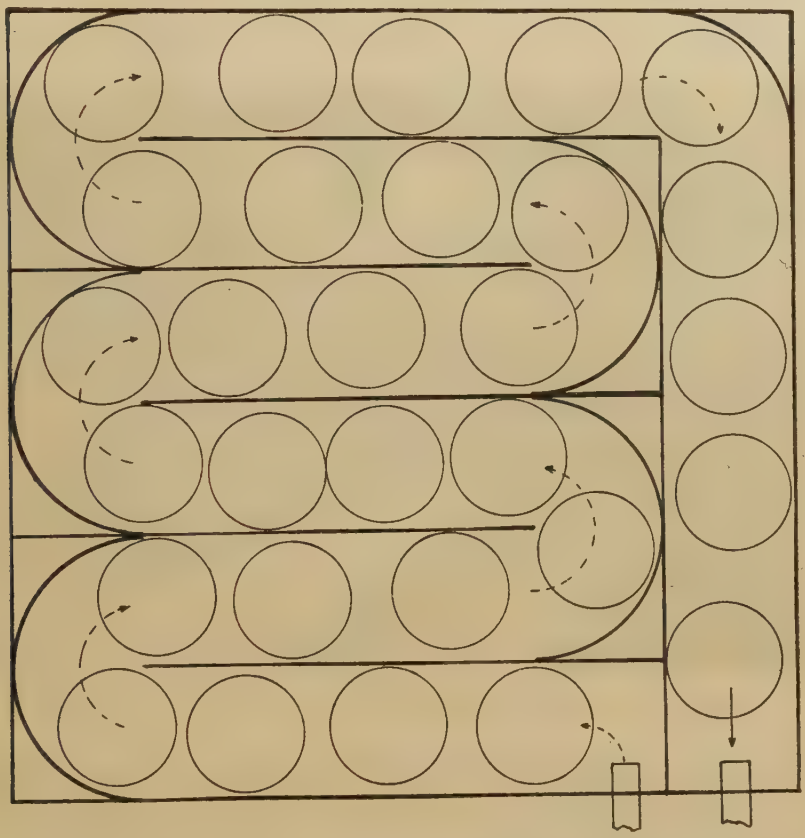

FIG. 42.—Kolbe's method of individual freezing for fillets and small fish. The circular pans float through the channel in the brine in directions indicated by arrows.

The advantages of simplicity and low cost of this method are at once obvious. While the writer has not had opportunity to see this plant, it seems that it requires some nicety of calculation in design to obtain best results. The buoyancy caused by entrapped air is overcome by the weight of the cans and the frames that hold them. The transfer of heat must take place through the top and bottom of the can, for the space on the sides between can and lid is occupied largely by air. If freezing is to occur on top, the pan must be well packed to obtain good contact with the lid. At the

bottom of the can brine must be in contact. If the depth of the lid is calculated for this condition in the top can, the others also will be bathed on the bottom. Of course, a leak, even a tiny one, in the lid, would allow the air to escape and brine would strike the fish.

Kolbe has also devised [76] an ingenious method of freezing fillets and fish individually. The apparatus, consisting of a shallow, insulated tank, is fitted with galvanized sheet-iron partition baffles that divide the tank into a labyrinth or devious channel returning to a point near which it starts. Cold brine is pumped in and flows through this circuitous channel at a moderate rate of speed.

The fillets or fish are put in circular pans or boats made of galvanized sheet iron, 18 inches in diameter and 3 inches deep. These

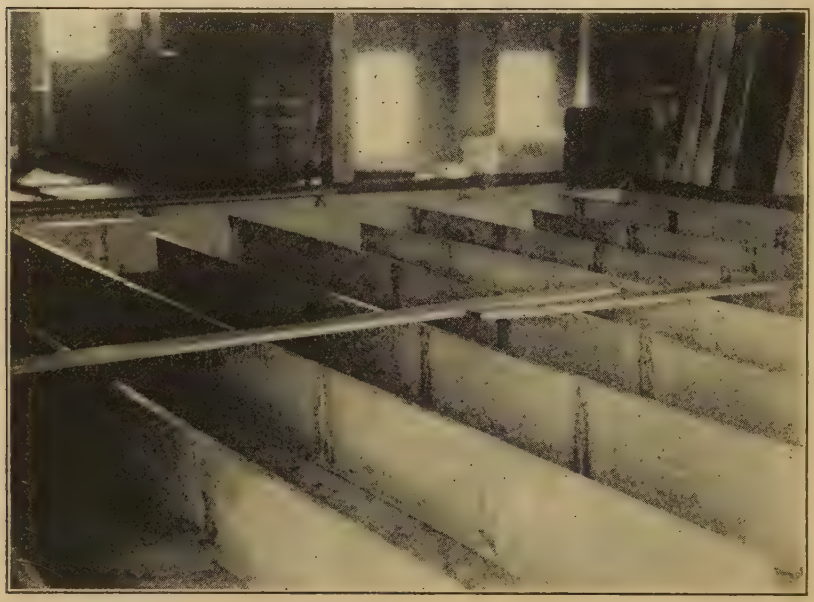

FIG. 43.—Kolbe's method for fillets and small fish. The maze tank, uncovered to show arrangement of baffles. Courtesy, Kolbe Fish Co.

boats are laid in the floating brine, whereupon they follow the stream through the channel, returning to a point near the starting point. The same operator loads the cans, starts them on their way, and receives them on their return.

At the completion of freezing the pans are removed, drained for a moment, inverted, and knocked against the wooden table. The tank is heavily insulated and has an insulated cover. The fillets or individual fish fall out and the pan is ready for repacking. The pans, being circular, do not jam in their course through the freezer, and the freezer may be filled to capacity with them without interference. Fillets of blue pike freeze in from 20 to 30 minutes with brine at about zero. Whitefish, being thicker, freeze in about 3 hours at this temperature. More rapid freezing can be obtained, of course, in brine of lower temperature.

[76] Patent pending (December, 1925.)

BIRDSEYE'S METHOD

Clarence Birdseye, of New York, adapted the can-immersion principle to the freezing of fillets of fish.[77] Because of exposure of much cut surface fillets must, almost of necessity, be frozen not in contact with brine. For convenience of handling it is also an advantage that they be frozen in bricks or blocks, to which form they

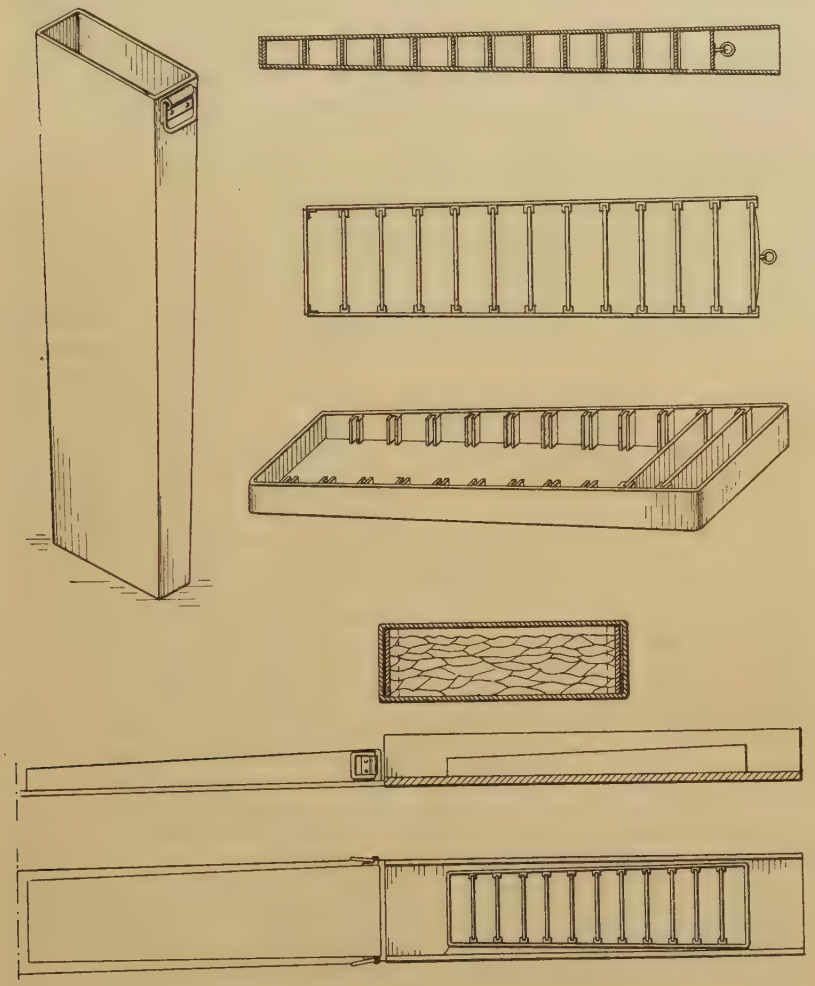

FIG. 44.—Birdseye's method of freezing.

are well adapted by their flabbiness.[78] The can is deep and narrow, with a slight taper. For filling the can there is provided a frame made of strap iron with removable cross partitions of metal. These cross partitions are arranged at such intervals that the interspaces will contain units of the desired sizes and weights—5 or 10 pounds.

[77] U. S. Patent 1511824, Oct. 14, 1924.

[78] The preparation of fillets of fish is described by Harden F. Taylor in "Modern methods of merchandising fish," published by the Patterson Parchment Paper Co., Passaic, N. J.

The can is laid upon its side on a working table. The frame, with partitions in place, is laid on a board with the end at the mouth of the can, the board raising the frame at such an elevation that it will slide directly into the can without disturbing the fillets. The fillets are packed and arranged in the spaces between the partitions of the frame, and the latter is slid into the can. The can is then upended and let down into the brine tank, the top protruding somewhat above the brine level, as in Petersen's system. The cans, being handled singly, are not heavy enough to require a mechanical hoist but are lifted by hand. When the fillets are frozen, the cans are withdrawn and dipped a moment in water, whereupon the frame is pulled from the can and the frozen bricks of fillets are released and packed.

Another form of Birdseye's freezing mold is a flat can opening at a large side instead of at the end. A side lid is arranged to be fastened on by means of thumb nuts and a gasket to prevent entrance of the brine. This mold is immersed bodily in the brine.

This method of Birdseye's was designed to meet a more specialized business than were most of the other methods hitherto described; namely, the dressing of fish and preparing fillets for cooking and freezing, all at or near the point of production of the fish, for shipment to consumers. The frozen bricks were packed in insulated containers and, containing their own refrigeration, went forward without ice as dry packages. Birdseye at first used a double-wall box made of corrugated strawboard, with dried eelgrass between the walls. He later adopted the simpler and less expensive practice of insulating ordinary corrugated strawboard boxes with two or more extra thicknesses of the same material cut in panels to fit the sides, top, and bottom of the box.

If the fish contain 75 per cent of water, all frozen, the package contains the equivalent of 60 or 70 per cent of its net weight in the form of ice for refrigeration. Ordinary shipments of fresh fish on ice usually have the same weight of ice as fish for refrigeration. Thus the contents of a box of 100 pounds net weight of fish would, together with the ice, weigh 200 pounds, only 50 per cent of the contents being fish. In the frozen bricks a shipment of 100 pounds of fish without ice would contain the equivalent in refrigeration of 60 or 75 pounds of ice, total weight of contents 100 pounds—an obvious advantage. Furthermore, the reserve refrigeration, being contained in rather than around the fish, is protected from loss by the insulating effect of the fish itself, for we have already seen that the thawed layer of fish around a frozen core during defrosting is a relatively poor conductor of heat. The economic soundness of this method of preparing fish for transportation is further substantiated by the removal of all nonedible parts of the fish and the use of a much lighter shipping package.

While Birdseye's business establishment was not a financial success, the methods he introduced appear to be economically sound and his freezing apparatus inexpensive and practical. As will be seen later, the fundamental ideas have been improved by others and are being applied in practice.

A simple experimental box, operating on Taylor's brine-spray principle, was put into practice by The Atlantic Coast Fisheries Co.

in New York in 1924. The apparatus is an insulated wooden chamber, 4 feet square and about 7 feet high, with a side door. A refrigerated coil was mounted in brine in the bottom of the chamber. A pump draws the brine from the tank and forces it through spray nozzles in the top of the tank. The fillets were packed in circular tin cans, $2\frac{5}{16}$ inches deep and $12\frac{1}{4}$ inches in diameter, holding 10 pounds and provided with lid. These cans were suspended in iron frames in the spray chamber and frozen, the temperature of the salt brine ranging from 5° below zero to several degrees above.

The fillets were stored and shipped in the cans. For shipping, the cans were packed in insulated strawboard boxes. While the tins afforded ideal protection against desiccation and rusting in storage, they were unsatisfactory because they were expensive and because of rust that developed during storage, which marred the external appearance of the cans and discolored the fish. Some brine entered the cans on which the lids did not fit perfectly.

In order to overcome the difficulties just mentioned molds of cast aluminum were made, $2\frac{5}{16}$ by 9 by 13 inches, with a flat lid fastened on with two thumb nuts. These are suspended on an angle-iron frame and conveyed into the brine-spray freezer. The frozen blocks are wrapped in parchment and a craft paper ("Safepack"), two sheets of which are cemented together by asphaltum, making it waterproof. These wrapped blocks are stored in wooden boxes and for shipment are put in paraffined cardboard boxes and packed in the insulated corrugated box. Such boxes have been shipped successfully 1,500 miles in summer weather. In cold weather they usually arrive at their destinations frozen.

This method also is subject to objections. The aluminum boxes are corroded somewhat by the salt brine (aluminum corrosion is harmless, however), and the lids of the molds become warped by repeated expansion of the fish in freezing, allowing brine to enter. An improved type of can is of similar shape but made of galvanized sheet iron, having an overlapping lid at one end, which is fastened on. The can is suspended by the lid and brine can not enter.

COOKE'S METHOD

A. H. Cooke, of The Atlantic Coast Fisheries Co. of New York, devised a method of freezing, particularly for fillets to be shipped after the manner of Birdseye, which is carried out in an apparatus consisting of aluminum pans of double wall.[79] Calcium chloride brine circulates between the walls equipped with temperature-collecting webs.[80] Instead of a lid on each can the cans are nested or stacked in such a way that the bottom of each can furnishes the refrigeration for the top of the fish in the can below. Two recesses are provided in each pan for two 10-pound blocks of fillets. Five such double receptacles, one above the other, form a battery that will freeze 100 pounds of fillets at a charge.

Such receptacle pans have calcium-brine inlet and outlet pipes on opposite sides of the middle of the pan, connecting by a swivel

[79] Patent pending.
[80] See Hesketh and Marcet, British Patent 6117 (1889), for first disclosure of this idea.

joint. These pipes also connect by swivel joints with the brine-feeding and discharge headers, so that the pans can be raised, one at a time, turned up side down on the swivel joints, and the cakes dumped. The pans are counterpoised by weights on pulleys.

For loosening the cakes of frozen fillets in the pans a measured quantity of warm calcium-chloride brine is admitted from a tank into the wall spaces of the pan, forcing the cold brine out and back into the refrigeration system. When a quantity of warm brine just sufficient to displace the cold brine has been pumped in, a double-throw valve is operated to circulate the warm brine in a circuit of its own. Thus, the cakes are loosened and fall out. When the re-

FIG. 45.—Cooke's method of freezing cakes of fillets. Machine in the foreground closed and freezing. Machine in background opened and being discharged. Courtesy, Atlantic Coast Fisheries Co.

ceptacles are empty the valves are reversed, driving all of the warm brine back into its tank, when, as the cold brine just fills the receptacle wall spaces, a valve is thrown, which puts the receptacles entirely in the cold-brine circuit again for freezing. An indicator guides the operator in operating the valves so as to loosen the cakes in the receptacles without mixing the hot and cold brine. The exposed surfaces of the freezing molds are insulated with corkboard.

While this apparatus is somewhat complicated and perhaps more expensive to construct than some of the others, it undoubtedly produces frozen fish of excellent quality, frozen rapidly and without contact with brine. With about one hour required, from the beginning of freezing of one batch to the beginning of the next when the brine is at 10° below zero, one battery of five double molds will freeze

800 pounds of fillets in an 8-hour day, or 4,000 pounds in five such batteries, one man being in attendance by rotation on the five batteries. There is some loss of refrigeration in repeatedly warming and cooling the apparatus, but this is not a large loss because of the low specific heat of aluminum (about 0.20).

The fillets are packed in temporary sheet-metal pans that hold 10 pounds each. From these pans the fillets are transferred to the freezing receptacles. When the calcium brine is 10° below zero, freezing is completed in about 50 minutes on cakes of the dimensions mentioned. Lower temperatures and consequently more rapid freezing is practicable, of course.

FIG. 46.—Cooke's method for individual fillets. Frozen haddock fillets being taken from freezer. Courtesy, Atlantic Coast Fisheries Co.

INDIVIDUAL FILLETS

Cooke also has designed a freezer of somewhat similar arrangement for freezing individual fillets. The fillets are laid on aluminum plates about 30 inches square and $\frac{3}{16}$-inch thick. These plates are placed on hollow shelves contained in an insulated cabinet. The shelves are of cast aluminum with internal webbing that constitutes a labyrinth through which the cold calcium-chloride brine circulates. The webbing serves two purposes—namely, to distribute the cold brine uniformly throughout the shelf for uniform freezing, and to conduct the heat away from the surface of the shelf more rapidly than it would be conducted by a smooth surface. The brine inlet and outlet are attached to opposite edges of the shelf and are provided with double-throw valves, so that cold brine may be circulated

for freezing and warm brine for slight defrosting so that the plates may be removed easily from the shelves.

The outside upper surface of each shelf is very slightly concave, so that when the shelves are warmed for removal of the plates the drip from the water condensed on the apparatus collects in this slight concavity. When the plates are again placed on the shelves, the water makes a physical contact between plate and shelf, which becomes ice when refrigeration is again turned on. This ice bond between plate and shelf serves to conduct heat rapidly and to insure rapid freezing. There are 12 shelves on each side, or 24 shelves in one cabinet freezer, taking about 250 pounds of fillets.

FIG. 47.—Cooke's method for individual fillets. Removing frozen fillets from plate and putting on fresh ones. Courtesy, Atlantic Coast Fisheries Co.

In operation, the fillets are laid, skin side down (the skins usually are removed), on the plates. The loaded plates are placed in a rack superstructure mounted on a flat truck and are moved to the freezer cabinet. They are put on the warm shelves, which, as stated, have water on their upper surfaces. The cabinet doors are closed and the cold brine is turned on. At a temperature of 10° F. below zero haddock fillets freeze in about 50 minutes; at 25° below, in less than 40 minutes. When fillets are frozen the warm brine is turned on, the plates are removed and transported back to the plating tables, and fresh plates are put in the freezer.

The plating table is really a frame to receive one plate at a time. It is provided with a series of perforated pipes connected with the city water supply. Water is turned on momentarily and is squirted

from the perforations against the lower side of the plate and warms the plate so that the fillets may be removed. Fresh fillets are then placed on the plate.

The advantage of rapid freezing of fillets in this apparatus without contact with brine is obvious. It is also simple and practical. The advantage of compactness, which it embodies, is of importance, inasmuch as the surface required for individual freezing is relatively very large and will take up a prohibitive amount of space if spread out. Two cabinets of 24 shelves each can be placed on a floor area of about 3½ by 15 feet and will freeze about 500 pounds of fillets an hour with brine at 10° F. below zero. The fillets are flat and are frozen straight.

LIQUID AIR FOR FREEZING

Liquid air has been proposed as a refrigerant for fish[81] by Bailey. The inventor's container for liquid air was claimed to make practicable the control of temperature in a room by regulating the evaporation of the liquid. Even if liquid air were available at a moderate price (which it is not), it would scarcely be suitable for freezing fish. While liquid air has a temperature of about 342° F. below zero, the amount of refrigeration it contains is, pound for pound, actually less than that in ordinary ice. Ice has 144 B. t. u. per pound; liquid air about 122. It would freeze fish very quickly, but even if frozen in liquid air it would be impossible to hold the fish at anywhere near that temperature.

WINTER-FROZEN OR NATURALLY FROZEN FISH

In cold climates in winter fish are taken through holes in the ice and allowed to freeze in the cold winter air. This practice is followed in Canada, Russia, and other northern countries.

METHOD OF CATCHING FISH THROUGH HOLES IN THE ICE

The simplest way is to cut a hole through the ice and fish with a hook and line or a long-handled dip net. For commercial purposes a more efficient method is followed, as described by Robbins[82] Holes are cut through the ice at intervals. A long, light pole is lowered into a hole and extended to the next. By this means a line is run from hole to hole, on which a gill net is fastened and let drop into the water under the ice. The fish entangled in this net are drawn out with the net, taken off, and allowed to remain on the ice until they are frozen, or nearly so. The air may be, on occasions, as cold as 40° F. below zero. Snow is gathered, to be used in packing with the fish in wooden boxes, and the fish are packed, if practicable, while they are still slightly soft. The boxed fish are allowed to remain on the ice until the fish are frozen solid and a wagonload accumulates, when they are hauled to a railroad station and shipped.

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[81] Bailey, "Liquid air as a freezing agent." Canadian Fisherman, April, 1918. See also, O. Simonis, Liquid Air and Its Possibilities. Proceedings, Fourth International Congress of Refrigeration, London, 1924, Vol. II, Sec. III, pp. 1094–1102.

[82] C. C. Robbins, "The fish production of the Great Lakes of the United States and Canada, and the practical application of refrigeration and cold storage." Proceedings, Third International Congress of Refrigeration, Chicago, 1913, Vol. I, Sec. III, pp. 543–552. Chicago.

Sometimes winter frozen fish are packed in snow houses and not shipped at once. They may be held for months, packed in snow houses, frozen solid.

These fish are not glazed, but the conditions under which they are kept virtually preclude desiccation and rusting, so that glazing is scarcely needed. Fish frozen in this way are assured of one great point of superiority—they are absolutely fresh when frozen. The rapidity of freezing, however, may be highly variable, according to temperature and wind velocity. When the temperature is 40° below, the wind blowing a gale, and the fish are not piled, they should freeze rapidly and be of excellent quality. On a day with an air temperature of 10° above and no wind the fish would freeze slowly and would be damaged by internal crystallization. However, the conditions being entirely beyond our control, we may accept them as a bounty, enabling fishermen to earn something in such a winter climate and furnishing the public with an excellent product.

DEFROSTING AND COOKING FROZEN FISH

If, while the fish are freezing and during storage no changes take place other than mere solidification, they should, on thawing, return to their original condition; but we have seen that changes of a more or less serious nature may take place in freezing and storage. How may these changes be reversed on thawing and the fish restored to its original condition?

If fish are frozen rapidly, as in any of the newer rapid-freezing processes, and stored for a short time with a good glaze or covering to prevent drying, they may be defrosted rapidly or slowly, as desired, and will approach their original condition. In fact, a freshly brine-frozen fish may be put in the oven or frying pan while still hard, and it will be in every way indistinguishable from fresh fish.

EFFECT OF CRYSTALLIZATION AND COAGULATION

If during slow freezing some of the water separates from the tissues of the fish and freezes as crystals of water ice, on thawing these crystals turn again to water. If this water is to be reabsorbed into the tissues, it must have time. While it is absorbing the fish must not be squeezed or otherwise disturbed, else the water will exude and be lost. Likewise, if rapidly frozen fish on long storage undergo coagulation with separation of water, the water must be given time to be reabsorbed into the coagulated tissue on defrosting.

Slow defrosting is preferable, for the reasons given, to extremely rapid defrosting. The writer has observed that rapidly frozen fish that has been stored for more than a month is wet when defrosted in warm air and juice can be squeezed out; but within an hour the juice is reabsorbed and can no longer be squeezed out. Air-frozen fish on defrosting, especially if they have been stored for some time, are exceedingly juicy and will lose some juice with almost any kind of defrosting. This juice contains so much albumen that if heated it will coagulate like the white of egg. It represents not only a loss of weight but a loss of valuable nutrients and savory materials. For example, in a recent test made by the writer a sample of 15 pounds of a commercial brand of air-frozen fillets of haddock, individually wrapped, was defrosted in the original package. On defrosting the

fish lost 16 per cent in weight, and on being taken from the box and unwrapped they lost 7.8 per cent, or 23.8 per cent loss between the frozen boxed fillets and the defrosted and unwrapped condition. If fish like halibut are steaked before defrosting, the loss will be greater than in fish not cut, because the skin of the latter helps to hold the juice until it can be reabsorbed.

If drying has been allowed to occur in storage, the fish will have lost some weight. Some of this lost weight can be restored to the fish as it defrosts, either by condensation of atmospheric moisture on the cold fish, by embedding the fish in ice, or by immersion in water.

METHODS OF DEFROSTING

These are (1) allowing the fish to remain in warm air, (2) putting it in cool air in a refrigerator, (3) embedding in cracked ice, and (4) immersing in water.

1. When fish are left in the air of a room at ordinary temperature a considerable amount of water will condense on the surface, and some of it will be absorbed by the fish, especially if the fish has dried in storage. This gain may be from 1 to 3 per cent. Air defrosting, like air freezing, is slow, and for the same reasons, but it allows time for the reabsorption of the separated juice. There may be some drying of the surface if the thawing time is prolonged, with consequent impairment of appearance. To prevent this, the fish may be covered with a damp cloth.

2. Defrosting in a refrigerator or cold chamber is similar to defrosting in a warm room, but is slower. It offers a slight advantage, perhaps, in protecting the fish from bacterial infection and from surface drying, to both of which it is exposed in a warm room. Otherwise there seems to be no particular advantage in this method.

3. The freezing point of fresh-water fish is about 31° and of salt-water fish about 30° F. Fish will therefore defrost slowly when embedded in cracked ice that has a temperature of 32°. This method is still slower than defrosting in a refrigerator. It exposes the fish to water from melting ice. Some of this water is taken up by the fish, with a consequent gain in weight, to a greater extent than when the defrosting is done in air. Also some of the soluble substance is dissolved from the superficial parts of the fish. Cut surfaces are blanched and their appearance is not improved. Still, the slowness of the method allows time for the reabsorption of the juices.

4. Immersion in cold water is the quickest method and perhaps the one in most common use. The fish absorb water up to as much as 10 per cent of the original weight, restoring loss if any occurred in storage. If the fish dried very much in storage, the loss may not be completely made good. In this method also some soluble substances are removed from the fish. This effect may be diminished by adding a small amount of common salt to the water. The amount of salt required would be about 0.7 pound to 100 pounds of water for fresh-water fish, or about 1.3 pounds of salt to 100 pounds of water for sea fish.

The reader who is interested in the theoretical principles involved in thawing is referred to Stiles[83] and to Plank, Ehrenbaum, and

[83] See footnote 47, p. 583.

Reuter.[84] The Dutch workers, Fortuyn and Van Driest, also carried out tests reported by Bottemanne.[85]

The conclusions from Plank's, Ehrenbaum's, and Reuter's experiments on loss of weight and on defrosting and cooking frozen fish may be summarized as follows: Fish that have been frozen for a week may be brought back to their original condition by either slow or rapid defrosting. In fish that have been kept frozen for a longer time the juice that has separated from the muscle substance is not reabsorbed.

The defrosting method followed (in cold water, ice, or air at room temperature) has, according to their experiments, no influence on the taste or keeping quality of the defrosted fish. Simple, quick, and convenient thawing in ice water seems preferable, while in air thawing some loss of weight may occur.

As soon as possible after the fish are defrosted they should be gutted. They will then keep as long as or longer than fresh fish held under the same conditions. Frozen fish, especially during defrosting, must be carefully protected from handling, bending, squeezing, or other mechanical disturbance that will press out any of the juice.

These conclusions seem sensible and practicable. Fortuyn and Van Driest, after some experimental work, recommended embedding the fish in cracked ice for defrosting. This is an extremely slow method, unnecessarily expensive, and not likely to be adopted generally.

COOKING FROZEN FISH

If the fish have been defrosted in accordance with the methods outlined, they may be treated as fresh fish in the kitchen. Joseph Bruna,[86] a French chef, recommends that frozen salmon be cooked without previous defrosting. His experience with frozen fish obviously is limited, for he says that salmon is the only fish suitable for freezing. Fish frozen in brine, or by any of the rapid-freezing processes, may be thawed before cooking, or they may be put in the oven or frying pan while still frozen. They will require a little longer to cook.

RATES CHARGED FOR FREEZING AND COLD-STORAGE OF FISH

The rates charged by fish freezers that do a public warehousing business vary, of course, with many conditions, such as the location of and investment in the plant, cost of power, water, and labor, kind of goods to be frozen, and volume and distribution of the business over the seasons of the year. Obviously, it would be unfair to make a comparison of the rates charged by various freezers without taking these factors into consideration. There are given here the published rates charged by three freezers separated by considerable distances geographically, which will give the reader a general idea of the rates charged in the United States and Canada.

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[84] See footnote 15, p. 518.
[85] See footnote 15, p. 518.
[86] Joseph Bruna, La cuisine des aliments frigorifiés. 40 pp. Association Française du Froid, Paris, 1919.

TABLE 25.—*Rates charged for freezing and cold storage of fish*

NEW YORK CITY

Goods received		First month	Second and subsequent months
Fresh, for freezing:			
To be pan frozen or spread—			
Lots of less than 12,000 pounds	per 100 pounds	$1.00	$0.30
Lots of more than 12,000 pounds	do	1.00	.25
To be frozen in packages—			
Large packages	do	.50	.30
Small packages	do	.70	.30
Clams, scallops, oysters, crab meat, etc., in cans	per gallon	.08	.08
Trunks of crabs	per trunk	.75	.35
Bait, barrels (200 pounds)	per barrel	.60	.40
Shad roes, season $0.10 per pair; monthly rate	per pair	.05	.01
Received frozen for storage:			
Lots of less than 12,000 pounds	per 100 pounds	.35	.30
Lots of more than 12,000 pounds	do	.35	.25
Small packages, smelts, etc	do	.40	.35
Smoked and dried fish, frozen temperature:			
Haddies, bloaters, etc	do	.35	.30

Goods received		10 days only	Second and subsequent months
For cooler:			
Barrels, 200 pounds	each	$0.50	
Boston boxes	do	1.00	
Salmon boxes	do	.50	
Fresh-water boxes	do	.40	
Scallops, tubs	do	.25	
Labor charges:			
Reglazing	per 100 pounds	.50	
Wrapping	do	.75	
Examination	do	.10	
Transfers that necessitate handling goods in storage	do	.125	
Minimum charge for any lot of fish		.50	
Boxes:			
Regulars	each	.90	
Mediums	do	.75	

BUFFALO, N. Y.

Goods received		First month	Second and subsequent months
Fresh, for freezing:			
Blue pike, 2,000 pounds or more	per 100 pounds	$1.00	
Blue pike, less than 2,000 pounds	do	1.25	
Other fish, 2,000 pounds or more	do	.75	
Other fish, less than 2,000 pounds	do	1.00	
Lots of 20,000 pounds or more	do		$0.125
Lots of 10,000 to 20,000 pounds	do		.15
Lots of 5,000 to 10,000 pounds	do		.20
Lots of 2,000 to 5,000 pounds	do		.25
Lots of less than 2,000 pounds	do		.30
Fish received frozen in boxes for storage:			
Lots of 20,000 pounds or more	do	.25	.125
Lots of 10,000 to 20,000 pounds	do	.25	.15
Lots of 5,000 to 10,000 pounds	do	.30	.20
Lots of 2,000 to 5,000 pounds	do	.35	.25
Lots of less than 2,000 pounds	do	.40	.30

Buffalo, N. Y.—For fish received frozen in bulk 10 cents per 100 pounds is added to cover additional labor in handling. When possible, fish are boxed when frozen, and charge for box and labor

is made in the first month's invoice. Empty fresh-fish boxes are subject to disposal at owner's expense after 24 hours unless shipping directions are given previously. The minimum charge is 5 cents per box.

Small fish, less than 12 inches average, are subject to a labor charge proportionate to the additional time required for handling. Reglazing and boxing is done at the cost of labor and material, plus 10 per cent. Fish are stored in bulk at the owner's risk of shortage, mixing, etc. For more than ordinary inspections goods are handled in the warehouse for weighing, sampling, or inspection at the customer's expense.

The monthly rate covers the period from the date of receipt to but not including the corresponding day of the following month, or any part of such period, excepting when the expiring day falls on Sunday or a holiday, in which case the next business day is deemed the expiring day. The storage rates specified include the labor of receiving, storing, and delivering the goods from and to the warehouse platform. Cartage to or from railroad depots and stores in the produce district and warehouses is charged at the prevailing rates of responsible truckmen. Deliveries requiring sorting for sizes are charged for extra.

Bay City, Mich. (*Petersen's method of freezing*).—The following is an excerpt from the freezing, keen-kooling, and cold-storage price list of a freezer in Bay City, Mich.:

Cake-freezing, glazing, and storage: One cent per pound (glazed weight) for cake-freezing, glazing, and storage until the end of calendar month in which received. Minimum charge for any shipment received for freezing, $5. Cakes will be marked with the words "Petersen frozen" and patent dates. Extra charge for freezing in divisible cakes, 15 cents per 100 pounds.

Keen kooling, glazing, and storage: Two cents per pound (glazed weight) for individual freezing (keen kooling), glazing, wrapping individually in special parchment paper or special parchment bags and storage until the end of the calendar month in which received. This price includes glazing boxes and lining boxes with parchment paper, as additional protection against evaporation during storage. Minimum charge for any shipment received for keen kooling, $10. All bags or wrappers will be marked with the words "Keen kooled" and patent dates.

Royalty: In addition to the above charges one-tenth of 1 cent per pound will be charged for all cake-freezing or keen kooling. This amount is the patent royalty charged us for the use of the superior Petersen rapid freezing systems which we have installed and are utilizing exclusively for all our freezing and keen kooling. Only articles in prime condition will be accepted for freezing or keen kooling. Boxes in which fish were received will, if desired, be returned to customer, transportation charges collect. All fish will be boxed before stored. Boxes are furnished at cost plus 10 per cent for overhead.

Storage on articles frozen or keen kooled: Twenty cents per 100 pounds per calendar month or fraction. Any lot on which this charge has been paid for six consecutive months will be held free of charges for any part of the subsequent six months. No handling charges are made on articles frozen or keen kooled.

Storage on articles received for general cold storage: Twenty-five cents per 100 pounds (gross weight) for storage per calendar month, or fraction thereof. Twenty-five cents per 100 pounds (gross weight) handling charges, including both "in" and "out," marking boxes, making out bills of lading, etc.

CHILLING AND ICING FISH FOR TEMPORARY PRESERVATION

For the temporary preservation of fish by chilling almost any of the methods described may be employed by removing the fish from

the freezing process before they are frozen through. The freezing point of salt-water fish is about 30.7° F. and of fresh-water fish about 31°. The respective classes of fish may be chilled to these temperatures without freezing. At such temperatures putrefaction and autolysis are not arrested but are greatly retarded. Fish so chilled will keep in good condition for several days. Kyle's method was designed to chill in concentrated sea water, and later, if desired, to freeze the fish. Dahl's method chills or freezes according to the time allowed for pumping the cold brine between the fish. The methods of Ottesen, Goër de Hervé, Mann, Piqué, Taylor, and Newton also may be used for chilling.

LARSEN'S METHOD

J. M. Larsen, of Copenhagen, designed a method [87] particularly for chilling fresh fish. He uses clear filtered sea water chilled to about 32° F., or a little colder. The fish are kept in this bath until they are chilled to a temperature approaching their freezing point, but not frozen. He also specified salt water in lieu of sea water and of about the same concentration. In this mild brine he claims that penetration does not occur, and that after 10 days the eyes are bright and gills pink, while gutted fish keep from two to four weeks in a much better condition than fish preserved by the usual methods.

There is a widespread assumption that because sea water is the natural element in which fish live it is inert and harmless as a bathing medium for dead fish. The nearest to an ideally inert solution for this purpose would be water containing the same mineral substances in solution in the same proportions in which they occur in fish. This is not true of sea water for any common food fish. Sea water contains about 3.5 per cent salts and a larger proportion of magnesium chloride than occurs in fish. Haddock contains about 1.45 per cent mineral salts in quite different proportions from those of sea water. The living fish is able to resist and regulate the osmotic penetration of the excess salts in sea water, but when dead it is not able to do so. Therefore there will be an interchange between the piece of fish and sea water when fish are bathed or chilled in it.

EATON AND CAMERON'S METHOD

A method [88] similar to Larsen's was designed by Eaton and Cameron, but differing from it principally in the use of ordinary salt brine 80 per cent saturated and flowing at a temperature of 12° to 15° F., wherein the fish are reduced to a surface temperature of 27° to 29° F. in 30 minutes without freezing. The principles underlying the effect of temperature and concentration of brine on the rate of penetration (see p. 578) indicate that under these conditions the fish would absorb much salt. A temperature of 12° may be reached satisfactorily in brine only 54 per cent saturated, and such a brine certainly would not penetrate as rapidly as the much stronger brine specified by these inventors. However, the inventors' first claim covers any temperature and concentration that will cool fish from 38° to 27° or 29° F. in 30 minutes.

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[87] U. S. Patent 1322312, Nov. 18, 1919. For a recent account of plans and claims for this method see "Politiken" (Copenhagen), Aug. 12, 1925.

[88] A. C. Eaton and W. R. Cameron, U. S. Patent 1404352, Jan. 24, 1922.

Eaton and Cameron's method of applying this invention is to float the fish in flowing brine in an elongated tank. A tank of this kind, used for the "Chilpack" product put up by the Deep Sea Fisheries, Inc., at Rockland, Me., is about 30 feet long, 5 feet wide, and 3 feet deep. Perforated wooden panels, attached to a moving chain, serve to carry the fish, fillets, or steaks under the brine and through to the emergence end, very much after the manner of Göër de Hervé (see p. 588). Pipes situated along the side walls of the tank keep the brine at from 20° to 25° during the freezing.

REFRIGERATION ON MENHADEN STEAMERS

Menhaden or bunkers (*Brevoortia tyrannus*), the fish that have been caught many years in large quantities along the Atlantic coast for the manufacture of fertilizer, fish meal, and oil, have been held in the holds of vessels without ice or other refrigeration. The steamers engaged in this fishery carry purse-seine boats that operate the seines. When the seines surround the fish and are pursed below, forming a bowl, the fish are scooped out, brought aboard the steamer, and dumped in the hold. Here it has been the custom to leave them, without ice or other preservative, until the vessel has accumulated a catch, when it proceeds to the factory. In the several days that sometimes elapse before the fish reach the factory much decomposition occurs, the odor becomes offensive in the neighborhood of the factory, and some nitrogenous material is made soluble by decomposition and is lost in the water pressed from the fish in manufacture. Recently a method of applying refrigeration to preserve the menhaden in the holds of the vessels was introduced by the Marine Products, Inc., of Reedville, Va. John A. Palmer, of that firm, in a private communication to the author, described the process as follows:

> On the steamer *Gloucester* we take sea water into two closed round tanks, 4 feet in diameter and 8 feet long, each having 2,200 feet of cooling coil. Ammonia is supplied to the coils through a manifold of five pipes, the outlets being similar. The fish hold is supplied with a false bottom, from under which sea water is pumped by a centrifugal pump through the tanks and to ¼-inch spray nozzles, which deliver the cooled sea water uniformly over the fish. The water percolates among the fish to the false bottom, where it is again picked up by the pump and put through the same cycle. After about six hours the water is slimy and is pumped overboard and replaced by fresh sea water. We use a double strainer next to the pump to remove scales, dirt, etc. The size of the compressor is 7½ by 7½ inch Frick two-cylinder. This has taken care of 250 tons of fish and prevented decomposition. The average temperature of the sprayed water is 42° F.
>
> The steamer *Louise* has cooling coils under the false bottom, and the water is pumped from there directly back to the sprays, but we have not had good results from this installation. We believe it to be because of the smaller compressor. The C. M. Robinson Co. of Baltimore installed the *Gloucester* outfit.

ICING FISH

Ice, the now almost universally used preservative for fish, has been used for many years. The first record of its use in the United States is that of a halibut smack out of Gloucester, Mass., in 1838, natural ice, of course, being used. It was slow of adoption, and at first the ice was not allowed to come in direct contact with the fish, but was used only to keep the hold cool. When it was found to do no harm the fish were packed in crushed ice. By 1845 ice was in

general use on these boats. Because of a prejudice against its use, iced packages were not shipped inland until 1858, when iced packages were shipped to New York as an experiment, whereupon adoption of the method rapidly followed.

The first use of ice on English North Sea fishing vessels was in about 1868; and with the establishment of a steam-trawling fleet in the eighties the taking of large quantities of ice aboard became the general practice, enabling the vessels to stay at sea as long as two weeks. Ice is now used in the holds of trawlers and in smaller boats for keeping the catch until it can be landed, in boxes and barrels of fish for shipment, in the bunkers of refrigerator cars, in piles to cover fish on the floors of fish houses, and in windows and show cases of retail fish stores.[89]

PROPERTIES OF ICE

The properties of ice that make it peculiarly suitable for preserving fish are numerous. As a vehicle for refrigeration it costs nothing or very little. The price of ice is largely the price of the refrigeration it contains. If any other substance is used to carry refrigeration, the vehicle itself may be expensive aside from the refrigeration it contains. Water, the melted product of ice, usually is harmless. Water ice contains more refrigeration per pound than can be put in most other common substances (even liquid air contains less, or only 122.4 B. t. u. per pound, as compared with 144 B. t. u. in water ice), though solid carbon-dioxide "ice" absorbs 249 B. t. u. in warming to 10° F. below zero. The temperature of ice is constant at the convenient temperature of 32° F., and this temperature can not be raised until all the ice is melted. Ice is convenient to handle, split, crush, and apply.

While the temperature of ice can not be raised above 32° F. without melting it, the temperature can be lowered below 32°, contrary to a prevalent impression, just as can the temperature of any other solid. A cubic foot of ice weighs 56.7 pounds, and the specific heat of ice is about 0.5; that is, 0.5 B. t. u. of heat is required to raise the temperature of ice 1° F. without melting it.

Natural ice is essentially the same as artificial ice. It may or may not be as pure, depending on its source.[90] It is generally cheaper where it is available, the cost being around $2.50 per ton, as compared with $4.50 to $6.50 per ton for manufactured ice. Manufactured ice may be made from ordinary water; but it is more generally made from either distilled water or is blown with a small stream of air during freezing to keep it in motion. When it is frozen in this way the impurities are driven to the center and removed, leaving a clean ice of satisfactory purity. Glacier ice is sometimes used in Alaska and other northern countries, but is not considered satisfactory for fish, being very hard and tending to impart a yellowish color to the fish.

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[89] For a description of the methods of icing and transporting fish in England see "The handling and transport of fish," by Edgar Griffiths and Crawford Heron. Department of Scientific and Industrial Research, Food Investigation Board, Special Report No. 5, 25 pp. London, 1925.

[90] H. S. Cummins (Journal, American Medical Association, Vol. LXVII, p. 751. Chicago, 1916) states that the slow crystalization of natural ice tends to purify it—an advantage over artificial ice.

EFFECT OF ICE ON FISH

Ice has no sterilizing effect on fish. If impure, it may have the opposite effect. It kills few, if any, bacteria, but by its cold only retards their growth. Neither does it arrest autolysis, but only retards it. The water produced by melting ice coming in contact with fish dissolves some of the soluble substances and causes some swelling and blanching of the tissues. It may also crush or bruise the fish, promoting autolysis instead of arresting it, and the water may cause a bleaching of the colors in the skin of fish.

To overcome the dissolving and bleaching effect of ice, sea-water ice has been tried for fish, but the use of this ice does not seem to have been adopted in practice. (See Larsen's method of chilling, p. 621.)

CHEMICAL PRESERVATIVES IN ICE

Attempts have been made also to fortify the preserving effect of ice by the addition of chemical preservatives. Sodium hypochlorite was tried and excited much interest in the industry a few years ago.[91] A solution containing sodium hypochlorite was sold under a trade name to be put in the water to be frozen. However, on investigations made by the British Food Investigation Board,[92] sodium hypochlorite failed to give promising results. In concentrations low enough not to taste or not to be injurious to health it failed to have any noticeable preserving effect. The same was found to be true of formaldehyde. They also investigated homoflavine and crystal violet, two dyes that are relatively harmless to man but exceedingly toxic to bacteria. In the presence of 0.1 per cent of ordinary salt these dyes will freeze uniformly in ice, but in permissible concentrations they failed to have any useful preserving effect.

The methods of using ice for fish are too well known to require lengthy description, but certain details are worthy of notice. Ice taken aboard trawlers and other fishing boats is usually crushed. Ice companies deliver the ice at the wharf, crush it, and chute it into the holds. Some fish freezers manufacture ice as a side line and crush it for the fishing boats. At some places elaborate arrangements are provided for this purpose, as at the Commonwealth Fish Pier in Boston. Aboard the boats the crushed ice is contained in barrels, boxes, bins, or loose in the holds. The customary method of packing is to alternate layers of ice and fish and cover the heap with a generous amount of ice. This practice is followed in the banks trawler fisheries of the East and the salmon, halibut, and cod fisheries of the west coast, and for snapper and other fisheries of the Gulf of Mexico.

DRESSING FISH FOR ICING

Large fish nearly always are gutted before being iced. This applies to cod, haddock, hake, pollock, halibut, and salmon. The heads are left on as a protection of the flesh, but in the case of hali-

[91] For particulars see Gibbs, Proceedings of the Fourth International Congress of Refrigeration, London, 1924, Vol. II, sec. III, pp. 1222–1244.
[92] Great Britain, Report of the Food Investigation Board for 1923, pp. 8–10. London.

but the heads are removed when the vessel lands. Smaller and medium-sized fish, such as croakers, spot, butterfish, shad, small weakfish, mackerel, mullet, and flounders usually are round. Gutting removes the focus from which infection may spread—the intestine—but exposes the belly cavity to the effect of water and infection of a different kind. In large fish, such as salmon and halibut, it is customary to fill the belly cavity with the crushed ice. For obvious reasons this hastens the thorough chilling of the whole fish.

ICING PACKAGES FOR TRANSPORTATION

For this purpose boxes or barrels are used. Where boxes are used a layer of ice is put on the bottom, then a layer of fish, then ice, and so on. There is no standard size of box, but shippers have their own shapes and sizes, usually designed to contain 100, 150, or 200 pounds net, of fish. One size of box, rated at 150 pounds, is 33 by 19 by 15 inches deep, inside dimensions, and is used in the Gulf of Mexico snapper fishery. A Great Lakes box measures 26 by 17 by 12 inches deep. On these boxes a board on each side is about 8 inches longer than the box proper, extending 4 inches on each end, to form handles and to prevent the boxes from being stood on end. A halibut box used on the west coast, rated at 200 pounds net, is 51½ by 25 by 16½ inches deep, inside measurements. This box has no end extensions for handles, but some of them have rope handles. Another box, used in California, is 34½ by 18 by 9¾ inches deep. This is rated at 150 pounds net.

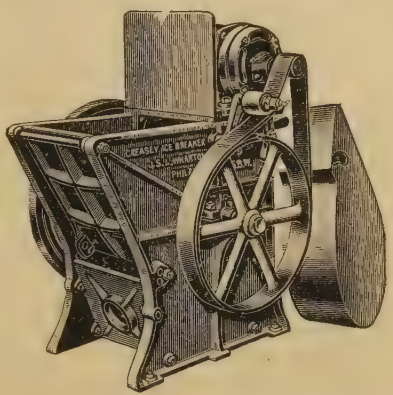

FIG. 48.—Ice breaker. Courtesy, Cochrane Corporation.

The common practice is to crush the ice used for fish. The smaller sizes of lumps are preferred—from ½ to 1 inch. Sailer[93] summarizes the answer given by 40 fish dealers to a questionnaire on the use of ice for packing fish. There is shown a general preference for boxes rather than barrels. The ice and fish layers are alternated, with a heavy layer of ice at the top. The amount of ice required for 100 pounds of fish varies from 50 to 100 pounds, according to the weather and the opinions of the packers. Ice that has been used once for packing fish rarely is used again for that purpose. There is also a strong concurrence of opinion among fish packers that fish should be thoroughly precooled in ice and repacked for shipment.

Every plant that uses much ice has a mechanical ice breaker. This is a revolving drum provided with steel spikes, inclosed in an iron casing, with a hopper for feeding in the cakes of ice. Such a machine (see figs. 48 and 49) will crush a ton of ice in three minutes.

[93] W. Sailer, "Broken Ice for packing shipments of fish." Paper read before the annual convention of the United States Fisheries Association, at Atlantic City, N. J., Sept. 2 to 5, 1925. Published by the Cochrane Corporation, Creasy Ice Breakers Department, publication No. 1360. Philadelphia, 1925.

Barrels usually are iced in the same way as boxes. Sometimes a "cone" of ice is used; that is, a long columnar chunk in the center of the barrel, surrounded by the fish. This method is especially suitable for eels. Sometimes a barrel is packed with fish and a large chunk of ice put on them at the top, but this is undoubtedly poor practice. For a head it is general practice to cover the barrel with a piece of burlap, which is held on by a hoop, which is nailed.

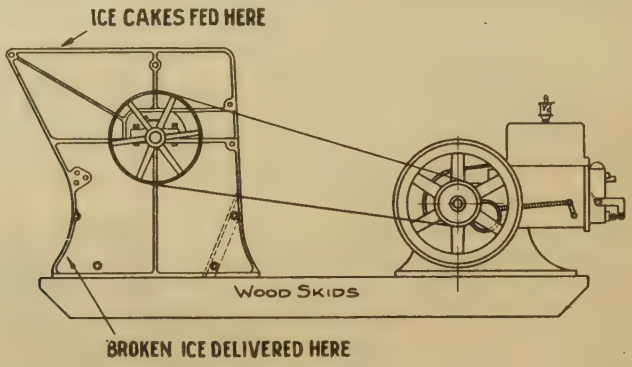

FIG. 49.—Arrangement of ice breaker driven by gasoline engine. Courtesy, Cochrane Corporation.

COMPARISON OF BOXES AND BARRELS AS CONTAINERS FOR ICED FISH

L. H. Almy, of the United States Bureau of Chemistry, and his coworkers have made several studies of shipments of fish on ice in in boxes and barrels.[94] They found a considerably greater shrinkage of fish in barrels than in boxes, as shown by Table 26, representing conditions in a carload of fish en route from Jacksonville, Fla., to New York.

TABLE 26.—*Shrinkage of fish in transit by freight, Jacksonville to New York*

Container	Layer of fish examined	Net weight of fish, pounds		Change in weight			
				Pounds		Percentage	
		Before shipment	After shipment	By layers	Total in package	By layers	Total in package
Box	Top	40	38	−2		−5.0	−1.3
	Bottom	40	41	+1	−1	+2.5	
Do	Top	38	33	−5		+13.2	−1.3
	Bottom	43	47	+4	−1	+10.5	
Barrel	Top	80	74	−6		−7.5	−6.6
	Bottom	130	122	−8	−14	−10.0	
Do	Top	108	106	−2		−1.9	−5.7
	Bottom	101	91	−10	−12	−9.9	

While these figures are not borne out by all their experiments, it is indicated clearly that shrinkage is greater in barrels than in

[94] L. H. Almy, H. R. Hill, and E. Field, "The shrinkage of fish in boxes and barrels." Fishing Gazette (New York), Vol. XXXIX, September, 1922, pp. 29–30. L. H. Almy and H. R. Hill, "Transportation of fish in boxes and barrels." Fishing Gazette, April, 1923. L. H. Almy, E. Field, and H. R. Hill, "A study of the preservation of fish in ice." The American Food Journal, Vol. XVIII, January, 1923, 36–38.

boxes, probably because of the greater pressure on the fish at the bottom of the barrels. The temperature conditions also are favorable to boxes in express shipments, as shown in Table 27, a shipment of fish in boxes and barrels from West Palm Beach to Jacksonville, Fla., in which temperature readings were made at intervals through the day. From 7 a. m. to 6.30 p. m. the temperature at the top of the barrel rose from 31.5° to 49.1°, while in the box the corresponding rise was from 33.1° to 41.1°.

TABLE 27.—*Temperature in transit by express, West Palm Beach to Jacksonville*

Readings for temperature of—	Apr. 22, 1922			
	7 a. m.	10.45 a. m.	2.30 p. m.	6.30 p. m.
	°F.	°F.	°F.	°F.
Fish in top layer in box	33.1	33.5	34.3	41.1
Fish in top layer in barrel	31.5	35.0	40.8	49.1

Experiments made by Almy and his coworkers on fish packed in boxes and held in ice in a cold room, where more exact work was possible, indicated that for the first few days there was a gain in weight in fish kept in ice, perhaps because of absorption of water, the greater gain being in the upper layer. By the tenth day the gain had stopped and a loss had begun, and after this the loss continued. Gutted fish generally kept better than round fish, but the gutted fish, on the average, showed more loss of mineral matter than the round fish. These writers recommend boxes in preference to barrels.

SHIPMENTS OF CARLOAD LOTS OF FISH ON ICE

These workers found that packages (boxes and barrels) placed in refrigerator cars and covered with crushed ice on and between the packages kept in excellent condition from Jacksonville to New York. Slat racks on the floor of the car permitted cold air to circulate under the packages. Another car of iced boxes and barrels was shipped, but the bunkers were packed with ice and salt and no ice was put on and around the packages in the car. The temperature conditions en route are shown in Table 28.

TABLE 28

Average readings for temperature of—	March—					Average for trip
	27	28	29	30	31	
	°F.	°F.	°F.	°F.	°F.	°F.
Atmosphere	70.3	54.7	66.8	58.3	59.0	61.8
Fish in barrels	32.0	31.7	32.0	32.3	32.0	32.0
Fish in boxes	32.5	31.8	31.8	32.2	32.2	32.1
Air in car	32.3	34.8	37.0	32.7	33.9	34.1

SÖLLING'S METHOD OF ICING FISH

A refinement in the method of icing fish was devised by Sölling[95] to avoid, as far as possible, the known causes of spoiling in iced fish; namely, the access of bacteria to the fish through the air and melting ice and the leaching action of the water from the melting ice. He also found, what Tressler[96] later determined by more precise scientific analysis to be a fact, that the blood of fish is more prone to spoil than is the muscle tissue, and that if blood is early and carefully removed the fish will be more perfectly preserved.

Sölling's method is as follows: The fish must be gutted and bled and the gills removed as soon as possible after the fish are caught. The sound must be split lengthwise to insure removal of the blood underneath, and the fish should be split behind the vent so that all accumulations of blood may be removed. The fish are then washed and scrubbed inside and out with a stiff brush and clean sea water or in a solution of 4 or 5 per cent salt in fresh water until all blood is removed. The fish is then laid aside to drain, care being taken that no water is left in the belly cavity.

Each fish is then carefully wrapped in vegetable parchment paper—a paper that does not disintegrate in water. The paper is cut square, and each dimension is at least one and one-half times the length of the fish. The wrapped fish are then packed in crushed ice. The fish are chilled by the ice but are protected from the water and air and consequently from bacterial infection.

Sölling packed experimentally 147 soles, turbot, brill, plaice, lemon sole, and witches (*a*) gutted, wrapped, and iced; (*b*) not gutted, but wrapped and iced; (*c*) gutted, not wrapped, but iced; (*d*) not gutted, not wrapped, but iced. Ten days later the fish (*a*) were still perfectly white and firm, with no odor, skin not discolored, and most of the fish had retained their stiffness (rigor mortis). The fish (*b*) were in most cases damaged inside. The fish (*c*) and (*d*) were soft, stale, and their skin was discolored. Fifteen days after being packed seven different kinds of the fish (*a*) were cooked and found to be perfectly fresh and of good flavor.

A lot of halibut, caught in Davis Strait and packed by Sölling's method, were shipped to Peterhead, thence by rail to Grimsby, where they fetched a comparatively high price three weeks after capture.

It is hardly to be doubted that such care in preparation will produce the results indicated, and there is little doubt that the care would be repaid. Improvements such as this must come in time as fish become dearer and the demand more fastidious; but whether or not this method can be applied on our fishing vessels as they are now constructed and operated is doubtful, indeed.

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[95] A. Sölling, "An Improved and Practical Method of Packing Fish for Transportation." Bulletin, U. S. Bureau of Fisheries, Vol. XXVII, 1907 (1908), pp. 295–301. Washington, 1910. See also, by the same author, "An improved and practical method of packing gutted fish for transportation keeping it fresh for a lengthened period." Premier Congrès International du Froid, Paris, 5–12 Octobre, 1908. Rapports et Communications, Sections I, II, et III, 2e Tome pp. 1072–1077. Paris. See also Second International Congress of Refrigeration, Vienna, 1910, pp. 375–378.

[96] D. K. Tressler, "Some Considerations Concerning the Salting of Fish." Appendix V, Report, U. S. Commissioner of Fisheries for 1919. Bureau of Fisheries Document No. 884, 55 pp. Washington, 1920.

ICING OTHER FISHERY PRODUCTS

Shucked oysters are shipped in large quantities in 1-gallon tin cans provided with friction lids. To guard against these lids coming out, two or three fourpenny nails are driven through the friction seal from the outside of each can. The cans are then imbedded in cracked ice in a wooden shipping box and shipped.[97]

FILLETS OF FISH

The practice of filleting fish at the point of production, freezing and shipping them, has already been described briefly under the head of freezing methods. The greater part of the business in fillets, how-

FIG. 50.—Wrapping machine for single frozen fillets. Courtesy, Atlantic Coast Fisheries Co.

ever, is in the chilled-in-ice rather than the frozen product, the greatest production being in Boston. The fillets, cut so as to have no bones, are wrapped in vegetable parchment paper and packed in rectangular or round cans. Sometimes the fillets are not wrapped but are packed in layers in the cans, sheets of vegetable parchment or other water-resistant paper separating the layers. The cans are covered with a lid, packed in cracked ice in a wooden box, and shipped. In some plants the fillets are given a preliminary chilling in a cold room before they are packed. This is an excellent practice, for if the fillets are a few degrees above the ice temperature they may

[97] As a guide to good practice in collecting, preparing, and shipping oysters see "Oysters," Ruling No. 9, Commissioner of Agriculture of Georgia, Atlanta; also "Rules and regulations for the sanitation of the oyster industry and to render its product readily marketable." North Carolina Fisheries Commission Board, Morehead City.

be many hours or even days in chilling completely because of the thickness of the can. A few degrees makes a great difference in the keeping of these fillets.

INSULATED PACKAGES FOR SHIPPING CHILLED FRESH FISH

Several inventors have designed insulated packages for shipping chilled fresh fish. The aim of all these inventions has been to chill fish to 32° F. or thereabouts and to insulate it in a package so that it will carry to destination in fresh condition. One of the earliest of these inventions used ice but provided sawdust to absorb the water from the melting ice. Later inventors, attempting to avoid the use of ice, made use of double-wall containers, with sawdust, eelgrass, corrugated paper, or other cheap insulating material between. The containers are generally of corrugated paper. Balsa-wood boxes also have been used for this purpose. The ideal at which these inventions aim is excellent but is difficult to attain because of the poor insulating quality of even the best insulators. If fish once chilled to 32° F. could be kept at this temperature, they would carry several days without spoiling, though even at this temperature deterioration occurs. Unfrozen water, however, requires a relatively small amount of heat in order to be warmed. Compare, for example, 10 pounds of frozen haddock at 28° with unfrozen haddock at 32°—only 4° difference. The haddock contains, say, 80 per cent water, and at 28° 62 per cent of this is frozen; that is, 4.96 pounds of ice in the 10 pounds. This is to be compared with 8 pounds of water at 32° in the unfrozen lot. To raise the 8 pounds of water in the unfrozen fish from 32° to 40° at 1 B. t. u. per pound would require $8\times8=64$ B. t. u. To melt the 4.96 pounds of ice in the frozen fish, at 144 B. t. u. per pound, would require $144\times4.96=714.24$ B. t. u. To raise all the 8 pounds of water from 28 to 40° would require $12\times8=96$ B. t. u. The total B. t. u. would thus be $714.24+96=810.24$ B. t. u., as compared with only 64 B. t. u. required to warm the unfrozen fish to the same temperature. If the external dimensions of the container are 1 foot cube, or 6 square feet, and the insulation is sufficient to pass 0.15 B. t. u. per square foot per hour, per degree difference in temperature between inside and outside (36° average for the frozen and 34° for the unfrozen), and the outside temperature is 70°, then 25 hours would be required to warm the frozen to 40°, and 2.1 hours would be required to warm the unfrozen to the same temperature. The time is not actually so short as this, nor the actual problem so simple, because the heat must penetrate the fish itself, but the difference will be relatively large. The prospects for an insulated package to keep fish fresh without ice in the fish or around it, therefore, do not seem bright.

TEMPORARY STORAGE OF FISH IN CHILL ROOMS

Most fish cold-storage plants have chill rooms where fish may be stored temporarily. The temperature of such rooms varies from 30° to 40° F., and a time limit is usually set to the storage of fish in this way. Barrels and boxes containing the fish are simply put in the rooms.

It is the consensus of opinion of those who are experienced in this kind of storage that fresh fish on ice maintain a better appearance if the temperature of the room is slightly above the melting point of ice, so that the fish are kept wet. If the room is too cold, the ice does not melt and the surface of the fish becomes dry. A temperature of 33° or 34° F. will allow the ice to melt very slowly. Such rooms are subject to the drip of condensed moisture from the walls and ceilings and sometimes the pipes; it is advisable, therefore, to place the fish or arrange drip pans so that the water does not drip on the stored goods.

Mild-cured salmon are held in some freezers at 30° to 32° F.; others hold them at slightly higher temperatures, ranging up to 38°.

The writer has chilled (that is, partly frozen) lake trout in brine, packed them in ice, and stored them at 28° F. for three weeks. They remained somewhat stiffened, but not hard, and were entirely good at the end of this time, though, as stated above, the skin was somewhat dry. On the other hand, haddock fillets frozen in 10-pound blocks were kept 6 weeks in a chamber in which the temperature was thermostatically regulated at 28°. At the end of that time the fillets were distinctly sour.

HOLDING LIVE FISH BY REFRIGERATION

It is known that many species of fish hibernate in winter; that is, they become inactive under the influence of low temperature, consume no food, and lie dormant for a long time. Carp have been known to be inclosed in solid ice and survive. (The freezing point of fish is lower than that of water, so that it is possible for fish to be inclosed in ice without themselves freezing.) Mir and Audige[98] devised a method of taking advantage of these facts by inducing hibernation artifically. The fish are held in tanks of aerated water, chilled to the freezing point. The fish become torpid. The water is then slowly frozen around them, care being taken not to lower the temperature below 32° F. The fish remain alive, dormant, and surrounded by solid ice, and if released by careful defrosting will still live. Oxygen must be present and available in small quantity, else the fish will suffocate, for they require a slight amount of oxygen to sustain life processes. This does not appear to be a practicable commercial procedure, though it might be useful in certain instances.

COLD-STORAGE LAWS

In the United States the power to regulate the holding of foods in storage remains with the States, several of which have enacted regulatory laws. No Federal cold-storage law has been enacted up to the time of this writing. Bills have been introduced in several sessions of Congress, providing for regulation, under the interstate commerce clause of the Constitution, of conditions under which cold-storage foods may enter interstate commerce. As frozen fish are so often shipped from State to State, such a law, if enacted, would have the practical effect of bringing all fish freezers and cold-storage ware-

[98] E. Mir and J. Audige, "Le transport des poissons congélés." Bulletin de la Société d'Aquiculture et de Pêche, tome 25, pp. 7–14. Paris, 1913.

houses under a Federal law, enforcible by Federal officers, and under the jurisdiction of Federal courts. These bills usually are worded so as to vest the enforcing power in the Secretary of Agriculture.

The provisions of the Federal Food and Drugs Act, administered by the Bureau of Chemistry, Department of Agriculture, apply to all foods imported, exported, entering interstate commerce, or manufactured, sold, or offered for sale in the District of Columbia or the Territories. The act does not mention cold storage specifically, but the selling of foods within the jurisdiction of the act after they have become contaminated or spoiled by cold storage is a violation.

A so-called "uniform cold storage law" has been enacted by many of the States. This law is, in its principal provisions, generally uniform, though modifications of a minor sort, and in some cases important modifications, have been made. The following States have enacted this law: California, Delaware (fish exempt), Indiana, Iowa, Louisiana, Maryland, Massachusetts, Minnesota, Nebraska, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Virginia, and Wisconsin. Kentucky, Michigan, South Dakota, and Utah have briefer and less restrictive laws. Florida has passed legislation providing for construction and operation of publicly-owned cold-storage plants. The uniform law, as enacted, places the enforcing power in the State department of agriculture, board of health, or food and drugs department, and usually gives the enforcing body discretionary power to make regulations under the law.

In most cases cold storage is defined as the holding of articles of food for 30 days or more in a cold-storage warehouse at a temperature of 45°—in some cases 40° F., or colder. A license to operate is usually required, a fee in most cases (but not all) being charged, ranging from $5 to $50 per annum. Records are required to be kept of receipts and withdrawals, and a report must be made monthly or quarterly to the enforcing body. In some cases the reports are compiled and are open to inspection. The enforcing body is given the power to inspect the premises of cold-storage plants, which, if found to be insanitary, may be closed or the license may be suspended or revoked. Goods are required to be marked with the date of receipt at the time when they are received for storage and with the date of withdrawal when withdrawn. In most cases the words "cold storage," or a similar mark, must appear on the package, and in a few cases the name and location of the warehouse where the goods were stored must also be shown.

In most of the States that have enacted the law a limit of 12 months (Delaware 6 months, Indiana 9 months, and Virginia 10 months) is placed on the period of storage, but the term may be extended in most cases on application to and inspection by the enforcing body. In some cases the term of extension is indefinite; in others it is 60 days, with a second extension of like length—a total of 120 days.

Most of the State cold-storage laws have clauses designed to enable the purchaser to ascertain whether or not foods have been cold stored. To this end they require that "cold storage," or similar device, appear on the goods, or that a placard to the same effect be displayed on the bulk of the goods when placed on sale. Some require invoices, advertising, etc., to state the cold-storage character of the foods.

Transfer of foods from one cold-storage warehouse to another is generally permitted if it is not done to evade the law regarding period of storage, markings, etc. It is prohibited to return foods to storage once they are withdrawn for sale.

In some of the States where no specific cold-storage law has been enacted the board of health or department of agriculture or food and drugs bureau has supervision over the sanitary and other conditions of cold storage.

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